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PROBLEMS CONFRONTING SMALL MANUFACTURERS IN AUTOMATING THEIR FACILITIES

HEARING

BEFORE THE

COMMITTEE ON SMALL BUSINESS
UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

SECOND SESSION

ON

THE USE OF ADVANCED MANUFACTURING TECHNOLOGIES BY SMALL BUSINESS

PART 2

MARCH 1, 1988

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THE USE OF ADVANCED MANUFACTURING TECHNOLOGIES BY SMALL BUSINESS

TUESDAY, MARCH 1, 1988

U.S. SENATE,
SUBCOMMITTEE ON INNOVATION,
TECHNOLOGY AND PRODUCTIVITY,
COMMITTEE ON SMALL BUSINESS,
Washington, DC.

The Subcommittee met, pursuant to notice, at 9:36 a.m., in room SR-428A, Russell Senate Office Building, Hon. Carl Levin (Chairman of the Subcommittee) presiding.

STATEMENT OF HON. CARL LEVIN, A U.S. SENATOR FROM THE STATE OF MICHIGAN

Senator LEVIN. Good morning, everybody. The Subcommittee will come to order. In the last hearings that we had on this Subcommittee we made reference to the tragedy of the erosion of our manufacturing base and our international competitiveness in the production of our goods, particularly the difficulties that small businesses have in keeping up with advanced technology machinery.

The lowering of our standard of living and the standard of living of our children that results from the erosion that we referred to continues unabated.

We learned that many small manufacturers have a lack of understanding of advanced technology and its application to their operation and that manufacturing processes have been largely neglected for the last 30 years.

In the meantime, of course, our major international competitors have been more successful in improving their process. We have learned that there are cultural barriers that have affected our adoption of the advanced technologies that have prevented us from pursuing the approaches that international competition has used.

We learned that the rapid changes and the demands in the global marketplace will not be met without the incorporation of advanced technology. We heard from small businesses on the barriers that they confronted in attempting to use advanced technology in their factory and, finally, we learned that in spite of all of these difficulties there were still world-class innovators.

We have a tremendous opportunity to capitalize on that innovative ability and to exploit it fully. If we fail to revitalize our ability to produce goods and let this opportunity pass, the economic future will be less secure.

The inquiry that we make today at these hearings is what the Federal Government is doing to meet this opportunity and whether or not these efforts are succeeding. If we meet with limited success, we must determine what is necessary to regain our role as the world-class producer that we ought to be.

We will also examine the difficulties that small businesses have in forming capital and the impact of tax policy on small businesses' use of advanced technologies.

The testimony that we will receive today will help us in our effort to determine what must be done to do a better job of harnessing our innovative ability to ensure our economic future.

Our first panel today is made up of two witnesses. I see now a third person present. Let me introduce the two who I am familiar with. First is Harold Corner, who is the cofounder, chairman of the board of directors and president of C&J Industries, a small manufacturing company in Meadville, PA.

Mr. Corner has adopted advanced technology in manufacturing processes to the point where his company is producing goods with higher levels of quality than our international competitors. Mr. Corner has also been involved with the Department of Commerce's shared facilities proposal and we would be asking him about that proposal.

Pat Costa is the president and the CEO of Robotic Vision Systems, Inc., a small firm that manufactures advanced technology equipment. Mr. Costa has experience with the Navy's rapid acquisition of manufactured parts program, the RAMP Program, and is familiar with other Department of Defense advanced technology programs.

Mr. Corner, Mr. Costa, we appreciate your coming today and look forward to your testimony.

Mr. Corner, we will call on you first.

Mr. CORNER. Thank you, Mr. Chairman. I would like to introduce the third person at this table, who is Mr. Bruce Hahn, who is the government affairs manager for the National Tooling and Machining Association and the past chairman of the Legislative Council, Small Business Legislative Council in the United States.

Senator LEVIN. We welcome him and, as always, are happy to have the support and assistance of that association.

STATEMENT OF HAROLD CORNER, PRESIDENT AND CEO, C&J INDUSTRIES, MEADVILLE, PA, ACCOMPANIED BY BRUCE HAHN, MANAGER, NATIONAL TOOLING AND MACHINING ASSOCIATION

Mr. CORNER. Mr. Chairman and Members of the Committee, my name is Harold Corner and I am president and chief executive officer of C.J. Industries in Meadville, PA. I am a former president of the National Tooling and Machining Association and the current chairman of the Metalworking Trade Association, whose 35 member associations representing 30,000 companies, employing over 1,800,000 employees in the United State's metalworking industry. I appreciate the opportunity to increase the rate of implementation of automated technologies among small businesses.

We believe that this is a critical issue facing our Nation today. An issue of such magnitude that it literally threatens the entire in-

dustrial base and the economy for future generations of this great country.

Nothing, I repeat, nothing can be mass produced in this world until a tool design engineer and a skilled toolmaker, designs, engineers, and fabricates a precision metal stamping die, forging die, a plastic injection mold for processing plastic component parts, jigs and fixtures for computer controlled numerical machining and turning center's, holding fixture's and special automated assembly machine, tooling for robots, and so forth.

These companies employ the skilled craftsman and the tool design engineer's absolutely necessary, to support our armed services in times of national defense. Many of these companies with 2d and 3d generation family members in management are the same companies which provided the necessary support for our armed services in World War II.

Mr. Chairman, you and the distinguished members of this committee must have a clear and precise understanding of this industry, its many problems with our Government legislation intended to help, which in fact does not, the horrendous problems we have and which we currently face in education, training, financing, marketing, quality, and global competitiveness.

Many nontechnical people in Government and academia are confused on exactly what this industry is, who we are and what services we provide to society. Quite frankly, this industry is perceived by most nontechnical people as the suppliers of screwdrivers, hammers, pliers, and so forth. This industry is quite often thought of as the U.S. Machine Tool Industry. Nothing could be further from the fact. This industry is the main customer of the U.S. Machine Tool Industry. We utilize their machine tools to fabricate the precision tools required for mass production of any and all component parts in the world.

We truly believe that this misunderstanding of just who the national tooling and machining companies are in this country, the vital services which they provide in defense of our country. The future of the industrial base in this Nation to become competitive in the global economy which we are currently living in, is a very significant part of this industries' problems. Educators, bankers, Members of Congress, State government officials, State legislators, and so forth, all must be enlightened on this industry and its' vital services to society.

Mr. Chairman, we need a much clearer succinct standard industry classification code or codes for this industry which would help eliminate the misunderstandings which currently prevail. We need an education system in this country and guidance counselors at the public education level who do not consider technical education as a second class education. This industry cannot possibly train employees for the future who are very badly, if at all, prepared in math, communication skills, English composition, reading, and so forth.

Training of skilled craftsmen and craftswsomen for the future of this industry will require a much higher level of competency in our trainees than today. As a matter of fact, the vast majority of employees entering this industry in the immediate future will require a bachelors' degree or at minimum, an associate degree in manufacturing engineering and/or computer sciences. All future employ-

ees must be fully cognizant and skilled in the application of statistics in the manufacturing environment.

We are literally appalled at the current statistics pertaining to the education of the country's next generation of employees. Statistics which indicate that almost 30 percent of this Nation's young people who enter high school every year, never finish. Statistics which also say that of those who do finish, two fifths in our central cities; New York, Chicago, Pittsburgh, Cleveland, and so forth, cannot read at the 9th grade level. While in Japan, all students are required to have accomplished learning in statistics to the equivalency of Statistics II, before being passed onto grade 10.

This country faces a monumental skills shortage in the next few years like it has never seen before in the entire history of our country. Advanced technologies can only be implemented by people, who are educated in the skills necessary, to implement and manage the technologies needed to be competitive in a global economy, i.e. F.C.I.M.

Management re-educating the existing managers in our existing companies, today, in the new management systems required to produce "world class" quality products, is crucial to the survival of all of Americas' industrial base. Big business, small- and medium-sized companies all over this country have a basic lack of awareness of management philosophies and systems which are a prerequisite for manufacturing of world-class quality products. This "lack of awareness" of what quality really means, this basic lack of understanding of statistical process controls, necessary to produce products in a "world-class quality" environment is truly this Nation's number one problem facing all the segments of industrial base, our service companies, the entire Congress and our complete educational system including our graduate degree programs and college and universities.

S.P.C. is not new. The basic handbooks in statistics were written in 1929, by Dr. Shewhart of A.T.T. These same handbooks are utilized today. Quality products and components for the supply of our armed services is one of the main reasons we were successful in World War II. Then after the war, demand for consumer products and capital goods was greater than this Nations capacity to produce. The world was at our feet begging for our products. We had tremendous industrial expansions. Our standard of living in this country rose to heights far beyond anywhere in recorded history of mankind. The industrial leaders, educators, and Members of Congress, evidently thought statistics applied in manufacturing processes were no longer needed in manufacturing—the demand for our products was more than our plant capacities could provide—so they were dropped from the curriculums of engineering bachelor degree program across this country. Financial management via MBA's became the name of the game at the expense of quality products, service, honesty, pride in craftsmanship; hence our current dilemma in this country. We are no longer the world's leading Nation in per capita income, producer of quality products, education of our people, and so forth. We are rapidly on our way to a Nation with dramatic standards of living being drastically lowered. Huge amounts of our people without jobs or qualifications in skills or education for jobs will not be "inner city" minorities, Mr.

Chairman, they will be the working middle class of this country. We will be compromised in defense of this Nation because of our industrial base and, specifically, if the small businesses that I represent here today are not salvaged, we will be dependent on foreign firms to provide the support necessary for our Armed Services—what a tragic legacy for our future generations that would be.

All of these terrible scenarios are the real world of today, because of a lack of quality, S.P.C. and management systems necessary to produce world-class products in a global market.

For example: The American Society for quality held its third national quality forum on October 13, 1987, in New York City. It was revealed at that forum—published in the February 1988 issue of Quality Progress Magazine—some of the results of this years' survey which was taken from approximately 615 executives of larger and smaller firms. The larger companies were selected from the Fortune 500 industrial and Fortune 500 service companies. The smaller companies were drawn from a data base of United States companies employing 20 or more employees—service companies represented approximately two thirds of the smaller companies polled. About 80 percent of those interviewed were chairmen, presidents, CEO's, chief financial officer's and vice-presidents, most of whom had served 10 or more years with their respective firm and 80 percent possessed degrees, with over one third holding advanced degrees.

Respondents were asked to list five companies that they associate with high quality. When comparing this year's list with last years, it was found that 10 companies either entered the list or moved up; seven of these companies were foreign companies. All six of the companies who moved downward to make room for them were United States companies.

Mr. Dana M. Cound, chairman of A.S.Q.C. board of directors reported, "How often their companies use the following programs or methods: Total quality control, evaluation of quality performance as part of the personnel evaluation process, statistical process control, visible top management leadership, skill training, quality improvement teams, employee involvement in problem solving and internal and external surveys.

The sometimes and often responses to these questions pose some very important questions. For example, how can you use total quality control sometimes; 16 percent of those interviewed responded that way. Thirty percent responded "often." It seems to me that total quality control has something to do with responsibilities and relationships and you either achieve it or you don't. How can 63 percent use total quality control "very often" or "often"; while only 38 percent use hourly employee involvement teams; only 39 percent claim to use salaried employee involvement teams; only 45 percent use statistical process control, and so forth? How can 71 percent say they use employee involvement in problem solving "often" or "very often", while only 38 percent use hourly quality improvement teams and 39 percent use salaried quality improvement teams, "often" or "very often?" Yet 81 percent lay claim to visible top management leadership. This kind of response, frankly, makes me very angry. It is the old motherhood and apple pie copout to the effect that everyone is responsible for quality. If this

is reflective of the quality of the visible top management leadership exhibited by 81 percent of the respondents, then the old adage is true—the enemy is us. Personally, I know of no one having a firm grip on reality, who believes these costs are less than 5 percent, yet almost half of the respondents make that claim. I firmly believe what we really have if 71 percent of the respondents who do not know, but 44 percent of them feel comfortable in guessing. These results reflect a tremendous naivety in the executive ranks on the subject."

We in the metalworking industries truly believe that quality is the competitive advantage. We believe a small percentage of this industry's companies have proven to themselves and their customers that quality, world-class quality, does not add cost to products—it reduces the total cost of products by nearly 30 percent. We believe, as James R. Houghton, chairman and CEO of Corning Glassworks reported at the National Quality Forum: "Total quality works totally and for America, quality is a way out of the jam we're in. Quality can restore us to leadership in a shrinking world where every dog is quickly eating every other dog. Quality can give us back our pride. Quality can make us believe in ourselves again. We can do it. We know how to do it. We invented it. The notion that quality is the competitive advantage isn't new. The real question is, "how do we get there from here?" The answer is to start with a little faith in our fellow human beings. Why? Because quality, plain and simple, depends on people."

Mr. Chairman, I am extremely proud to report to this Committee a true story of my own company, C and J Industries, and how we have struggled and labored since 1982, learning and implementing the philosophies of Dr. Edward Deming's 14 points. In 1982, our company was faced with financial chaos. Our entire customer base was either moving from the "rust belt states" to "sunshine states," overseas, or they were procuring their tooling "offshore" at supposedly less cost—which our industry can categorize as erroneous. We saw our interest rates move from single digit levels to over 21 percent on our working capital loans, our capital equipment loans, and so forth. We were like many companies in our industry, in dire financial condition.

But I stumbled onto the teachings of Dr. Edward Deming and I became infatuated with his teaching of statistical control and the philosophy of doing things right and his 14 points. As a result of this enthusiasm, I sought an outside consultant with a master's degree in statistics and more than 30 years of experience in private industry. This 71 year old gentleman—who was a student of Dr. Deming, Dr. Juran, and others—became mine, as well as my company's, personal tutor and still is today. He has taken the form of an external auditor on our management systems, which we have designed and implemented in our company and which we continually are improving on all the time.

Over these past 6 years, our company has progressed in our skills in statistical process controls in tool design engineering, thermoplastic injection, molded components, and complete turnkey manufacturing of medical devices, electronic assemblies and subassemblies for the automobile, electronics, computer peripherals, telecommunications, and the personal hygiene industries to the extent that

we are totally qualified with technical as well as management skills and systems, to produce all of our products to a level of defects per million pieces or "world-class quality." We currently utilize C.A.D., C.A.M., C.N.C. tools, micro processors, C.N.C. electronic optical measuring devices, computer monitoring of all process variables in our injection molding machines, and so forth.

Because of the tremendous investment which we have made in training and educating our people—which continues even at a higher cost today—in application of new technology, in development of standardized components for our injection plastic molds. We have recently succeeded in capturing a major component plastic part, utilized by our leading automobile manufacturing firm in this country today from the Japanese. The quality of our finished product is far superior, and the total cost to our customer is cheaper. We produce and we ship "zero" defective parts in a truly "just in time" delivery requirement. Mr. Chairman, I wanted to relate this story to this committee for several reasons.

First, and perhaps foremost, of the reasons is because I happen to know how dear and near the automobile industry is to your heart, as it is mine.

Second, I wanted to use this example to amplify to this Committee the significance of the concept of shared flexible computer-integrated manufacturing facilities across this country as proposed by Dr. Bruce Merryfield, Assistant Secretary of Commerce of the office of productivity, innovation and technology and his entire staff. In our industry's opinion, and most assuredly my personal opinion, these private sector-driven Flex/C.I.M. centers which O.P.T.I. has proposed and is promoting, is the most efficient, most effective and least costly method to help small, medium, and mature industries in America survive today. Our industries, for whatever reasons, simply have not been able to transfer but very little of the new technologies for which we, as taxpayers, spend billions and billions of dollars in research laboratories. Each year, certainly, this country must continue its R&D at its major labs and university labs, but if American industry is to survive the onslaught of global competitors, who keep getting better each day in their application of new technologies and management systems, we enthusiastically encourage all the Members of this Committee to support the concept of shared Flex/C.I.M. centers nationwide, as proposed by O.P.T.I.

Our members, and all members of the 29,000-plus companies in the metalworking industries, would very definitely be actively involved in the shared Flex/C.I.M. facilities all over this country. We would train and re-train managers in S.P.C., computer systems, computer networking and all related skills. We would have teaching factories run for profit by profit-oriented management in which we could prove to all industry executives, bankers, academians, economists, government officials, and so forth, that the application of new technologies can show a return on investment, and it will enable American industry to effectively compete anywhere in the world based on quality, price, service, and delivery.

The primary goal is to maintain and expand the small- and medium-sized manufacturing base in the United States so that they can compete with products from overseas. To do that, these companies need to automate. Computer-integrated manufacturing is not new. Companies such as GE and GM have made major investments in advanced automation. Yet, the multi-million dollar expense of factory automation—utilizing giant mainframe computers and sophisticated software packages—is beyond the reach of most smaller enterprises. Hence, the idea of applying the time sharing concept to manufacturing by creating a single state-of-the-art factory that can serve a number of businesses in a single region on a pay-as-you-go basis. "We're in a unique position—as the Rust Bowl of the Northeast, we have seen a major industrial community self-destruct as companies either moved offshore, got bought out or went out of business. But we still have a large base of tool and die companies with some of the most exacting skills in the world. Just as important, these survivor companies are committed to continued self-help.

The Institute's potential market includes about 350 small- and medium-sized tool and die firms within a 50-mile radius of Meadville. The goals are to demonstrate the benefits of computerized automation and to teach firms how to use it—either in their own plants or in the shared facility.

The factory itself will be built in five stages. The first four "cells" will be devoted to the automated production of component parts, starting with metals and followed by polymers, ceramics, and electronics. The fifth cell will be able to provide turnkey manufacturing by assembling products made in the other four.

The main key is Education. a comprehensive re-education effort—organized around the concept of "statistical process control," developed by quality guru W. Edward Deming—is that management education is the centerpiece of the entire program.

In February, fast-track seminars in statistical process control begin for CEO's later, second-level managers in such critical areas as manufacturing engineering, marketing and cost control will receive intensive training requiring them to shuttle back and forth between classroom and factory.

Phase two will involve using the factory as a facility for show-and-tell demonstrations. "A traditional company would need a minimum investment of $5 million to convert to flexibile manufacturing. Our concept will allow them to bring their widgets into our factory for a real demonstration of the feasilbility of the investment." Once the firm decides to go ahead and automate its own operations, the institute would provide training to assure maximum productivity.

The ultimate advantages for flexible, computer-integrated manufacturing can drive direct labor costs as a percentage of direct labor costs as a percentage of direct sales from current levels of about 30 percent to 2 percent or less. At that level, we can compete with any Third World country.

The Institute's principal requirement is $25 million in funding. I expect to need this up front, to purchase the site and buy the large

mainframe computers and software packages needed to make the factor operational. We anticipate a total investment of $50 million.

We expect most of the funds to be raised from the private sector, largely through the sale of services. Seed money is being sought from the State of Pennsylvania and Federal Economic Development Administration.

Mr. Chairman, I'm absolutely confident that this will work. We are the most ingenious society in the world. Give us the proper tools, training and capital formation and we can compete with anyone. If we truly believe that quality is the competitive advantage, then we must have faith in our people in this great land of opportunity. Quality is people informed and working together.

Tax incentives, such as the investment tax credit, low-cost guaranteed loans by the Federal Government to help small and medium companies acquire the very expensive, sometimes quickly obsoleted new technologies, are also essential for survival of small manufacturing firms. A total revamping of the procurement systems, of the Department of Defense, N.A.S.A., and State government is essential for the survival of small- and medium-sized companies. The traditional adversary relationship between customer and vendors, qualified to a common criteria in management systems required for defects per million manufacturing and world-class quality. Contract must be let for life of design of component parts, sub-assemblies and complete assemblies. The low bid-driven mentality in existence today must be eliminated immediately for several reasons:

No. 1, it is statistically proven that 25 percent of all manufacturing—labor resources—in American industry today is simply reworking defective manufactured component parts and time spent trying to inspect quality into components after they have been produced, instead of controlling the processes with statistical production control techniques. No. 2, without long-term contracts, no company can justify capital investments required to move into total Flex/C.I.M.—or any part thereof—facilities. No. 3, there must be a culture change in management of defense contractors for weapon systems, and supplies of component parts just as there must be culture change in management in the commercial section of the metalworking industries. Mr. Chairman, we urge all Members of this Committee who sit on the Armed Services and Government Affairs Committee, to seek a cooperative initiative, not only with those Committees, but throughout the entire Congress on these vital issues, which are affecting the survival of our industrial base today.

Thank you, Mr. Chairman, that concludes my remarks. I will be happy to try to answer any questions you may have, either on my comments today, or the prepared testimony with which I have provided to the Committee.

[The prepared statement of Mr. Corner follows:]

National Tooling & Machining Association

NTMA
PRECISION

TESTIMONY BY HAROLD CORNER

ON BEHALF OF THE

NATIONAL TOOLING AND MACHINING ASSOCIATION

MARCH 1, 1988

BEFORE THE

SENATE SMALL BUSINESS SUBCOMMITTEE ON

INNOVATION, TECHNOLOGY, AND PRODUCTIVITY

CONDUCTING HEARINGS ON

SMALL BUSINESS AUTOMATION

Mr. Chairman and members of the Committee. My name is Harold Corner and I am president of C & J Industries in Meadville, Pennsylvania. I am a former President of the National Tooling and Machining Association (NTMA) and the current Chairman of the Metalworking Trade Coalition, whose 35 member associations represent 29,859 companies in the U.S. metalworking industry. I appreciate the opportunity to share the views of NTMA on ways to increase the rate of implementation of automated technologies among small businesses.

We feel qualified to address the subject because all of the approximately 12,000 tooling and machining companies in our industry are small businesses. We believe that the question is an important one for several reasons. First, as you learned at your December 2, 1987 hearing, small U.S. manufacturers are not automating fast enough. As a matter of fact, a recent study (Frostbelt Automation: The ITI Status Report on Great Lakes Manufacturing; Sept. 1987) shows that the majority of small manufacturers have no intention of adding new types of automation equipment. Second, if the small businesses - just the ones in our industry alone - were to become technologically obsolescent, our entire industrial base would be threatened.

These small plants are the keystone of the U.S. industrial infrastructure. Until one of our member's toolmakers builds a mold, the parts made from that mold cannot be produced. Whether the customer is an auto manufacturer or his parts supplier, he can mold no taillight lenses, dashboards or thousands of other parts. Until another member provides the auto manufacturer with dies, no door panels, hoods or other parts will be stamped.

These companies are equally important to other vital customer industries - the electronics industry, the computer industry, defense and aerospace, appliances and many others. In fact, virtually nothing can be mass manufactured unless the services of these small U.S. companies or their foreign competitors are available.

The closely-related U.S. machine tool industry has provided compelling arguments as to the risk to national security under a state of national emergency should U.S. machine tools be unavailable or in short supply. As the users of those machine tools, we have to agree. We also have to point out to the Committee that while it could take several years to set up factories to produce machine tools, even under an emergency situation, it will take me no less than four years to turn an apprentice into a journeyman mold maker, diemaker or precision machinist who can use those machine tools.

Recently, NTMA submitted testimony intended to guide a new Department of Labor initiative titled "Apprenticeship 2000." To summarize our position, we essentially train today the way we have for decades. Our apprentice studies under the guidance of a craftsman for a minimum of 8,000 hours. The

basic concept set forth in the Apprenticeship 2000 initiative is that the nature of the changes facing the labor force suggests a more comprehensive and systematic approach to training highly skilled workers.

These workers are among the most skilled and highly compensated in the country. There are fewer and fewer young people available with an adequate math and science background as well as mechanical aptitude and a healthy work ethic. One of the problems is our basic education system, which is producing nowhere near enough potential apprentices as well as mechanical engineering graduates. NTMA will work to be integrally involved in the deliberations which will restructure apprenticeship. We plan to stress the linkage of our traditional training efforts with the existing public school education system. But, unless efforts are made to improve the competitiveness of both the machine tool and metalworking industries simultaneously by addressing these challenges, we may face the prospect of no machine tools being available and no machinists available to run them.

To date, our members have fared better in the trade wars than our cousins in the U.S. machine tool industry, but we haven't been untouched. In our favor are the advantages of small business and the ability to adapt to changing business conditions quickly. Not in our favor are most U.S. laws and the way they discourage investment by small firms which are generally starved for capital to begin with.

With that, let me discuss how we can address the challenge of increasing the rate of absorption of new technology in our industry and other critical metalworking industries.

There are many obvious means of addressing the barriers to automation faced by a small company. The recently repealed 10% investment tax credit served a shop owner nicely as a means of using part of his quarterly federal tax payment as a 10% down payment for a machine tool. The old accelerated depreciation schedules also kept his taxes low, which in turn helped keep his prices low. The only problem was that intense competition from the other 12,000 companies in the industry kept his profits low too. In combination, low taxes and low profits meant that the commensurately lower prices enhanced the ability of these companies to stay in business in the face of low priced foreign products. Maybe his company didn't pay a lot of taxes, but as an individual he and his employees paid their share. And more importantly, owner and employee alike kept their jobs so they contributed to our economy.

Also, we need a level playing field in international trade. There should be efficient and inexpensive remedies for unfair trade practices for small businesses. Therefore, U.S. trade laws, as well as trade remedies, both need modification. With the cost of bringing a case before the International Trade Commission running from $250-500,000, small businesses in effect have no present remedy to unfair trade practices. We realize these observations would be

better directed at the Finance Committee (and they have been), but we point them out to you as tax incentives and a more fair international trading environment are ways to increase automation just as elimination of incentives is one way to decrease it.

The owner-managers of the 3,200 companies in NTMA repeatedly tell us that their top technical problem is training. The need for training extends from the entry-level job applicant to the chief executive in these small firms. A continuing need for shop-floor level training in all the currently available technologies exists. Managers need training and education not only in how to use these new techniques, but also in how to acquire, manage and market them.

Our concept for the National Institute for Flexible and Computer Integrated Manufacturing differs from other so-called shared facilities in that its principle purpose will be to serve as a "teaching factory" and not so much as a permanent hi-tech subcontracting facility. Private sector clients would send employees to learn, test and demonstrate new techniques before sinking risky and expensive investments in new equipment. Once a satisfactory trial is accomplished, the sponsoring company would absorb the new technology into its own facilities and the teaching factory would move on to another project with another client.

Reducing direct labor cost is no longer the principal motivation for small skill-intensive companies to automate. Automation may be the only route for many smaller firms to achieve the marketplace's vastly greater requirements for quality, speed, and flexibility.

Our proposed center, and others like it, with both government and private support, would do much to help small firms breach the many and considerable obstacles that now stand in their way.

I would like to turn to some other constructive ideas we have which should be helpful to your efforts. Several years ago I began investigating possible solutions to the same problem we are discussing today. Here is my list of common reasons (other than financial and trade laws) that small businesses in our industry don't invest in new technologies at a faster rate:

New technology is by definition unproven. A machine tool builder can tell me the productivity potential of his equipment under ideal conditions, but not under shop floor conditions, which is critical. At what sustained production rate can it run, how often will it break down? How much will it cost to fix? How quickly will it be serviced? Will it be suitable for all of my potential applications? Will it be easy or difficult for my employees to use?

Our Association has an ongoing machine tool users survey, but there is precious little information on equipment that's been on the market only a short time. Many other questions

relate to utilization of advanced, new equipment. Can I sell enough additional hours of machining time to my customers to bring down my hourly cost to a level where my prices are competitive?

With these many questions which we face, we have some sympathy for financial institutions who have even less knowledge and understanding about new technologies and are thus often reluctant to make loans to finance their purchase.

A further complicating matter is that when new, advanced technology equipment is purchased, and training is conducted on it, the company imposes limitations on the acquisition of other types of equipment, as well as equipment which could be developed within the near future. This is because of the incompatibilities encountered between different control systems and software. The languages spoken by the modern technologies needed to automate are different.

A common, universally accepted interface is needed which will allow advanced automation systems to communicate among themselves as well as with the factory equipment companies presently own. I recognize that the National Bureau of Standards is conducting the background work which would be needed for the establishment of interface standards. I am also aware that if such standards are to be effective, the private sector has to support and implement them. The convening of a consortium of government, education, and private sector leaders in information systems to develop and implement a universal interface standard would greatly assist in the effective automation of our industry.

I see that the Senate, under the provisions of S.907, the Technology Competitiveness Act of 1987 (included in the Senate trade bill), is attempting to help resolve this "knowledge" problem by creating a clearinghouse of effective state level technology transfer programs, and by creating twelve regional centers for the transfer to small businesses of manufacturing technology developed at the National Bureau of Standards and at other federal labs. I urge members of this Committee to support these provisions in negotiations on the trade bill and in subsequent Senate floor votes on the completed trade package.

But in addition, Mr. Chairman, I would like to address a concept in the initial version of S.907 that is not included in the trade bill: the <u>leasing</u> of manufacturing equipment to small businesses. The concept was to have the federal government purchase up to $50 million worth of advanced manufacturing equipment, and lease the equipment to competing small businesses. The concept of leasing to small businesses is very important, but I agree with the Senate Commerce Committee's decision to reject the concept as initially included in S.907. My reasons are twofold. One is that a total of $50 million spread over thousands of businesses would have very little impact. Secondly, there is a leasing concept developed by the Department of

Commerce's Office of Productivity, Technology and Innovation that would be much more effective for one very important reason - it is driven by the private sector concept.

This shared leasing program would be funded primarily by the private sector through state-of-the-art Flexible Computer Integrated Manufacturing (FCIM) factories which would be strategically located throughout the country. These factories would be manufacturing service centers that would include hands-on management and technical training on advanced manufacturing equipment. The production services of this equipment would be leased to small companies and would allow them to produce small batches of products competitively, as well as enhance their peak capacity requirements.

As a result, through both the training and production leasing provided, small businesses involved would become capable of determining the most applicable technology for their shops, and would know how to manage that technology once adopted.

Equipment utilization rates would, by nature of the leasing concept, be kept at very high levels in these shared factories, and the financial institutions would have successful, profitable examples on which to base their decisions.

The OPTI program takes into account that small businesses in the private sector know best what they can utilize, be it federally developed technology or technology developed by a neighboring firm in the private sector. One of OPTI's primary objectives under the program is to assist small companies, through shared centers, to learn the best practices for managing state-of-the-art manufacturing processes. We don't need, nor do we want, the federal government controlling what technology we buy. That will hinder our efforts to automate. However, we do need the Congress to support our initiative.

Another important benefit of the OPTI shared leasing program would accrue to the builders of the equipment. In addition to the substantial expansion of their markets, they would be able and indeed encouraged to study, in one facility, the myriad of applications to which the equipment is being put. The communications improvement between vendor and customer would both aid the refinement of designs and the development of new designs.

A similar concept has already been implemented in Italy. Thousands of new businesses have formed, and tens of thousands of new jobs have been created there. It shows what our country could easily achieve domestically if we want to resume the role of world leader of industrial technology applications.

We feel that the shared leasing concept developed by OPTI needs to be implemented immediately. In that regard, I have

spearheaded the establishment of the National Institute of Flexible Manufacturing to act as the demonstration model for the concept. The National Tooling and Machining Association fully supports the concept and the Institute. At its most recent meeting, the Executive Committee of the National Tooling and Machining Association unanimously voted to support the National Institute of Flexible Manufacturing.

In order to make the concept and the demonstration project a reality, financial cooperation will be required between the federal government, state and local governments, training institutions, and the private sector. The Congress needs to strongly support the demonstration in FY 1989, and then provide seed monies thereafter for the concept to quickly expand throughout the country. Whereas the initial version of S.907 was considering an authority of $50 million in FY 88 for lease equipment, this lease program would require less than half that amount in FY 89, and be strongly leveraged with non-federal funds. An expanding group of large equipment suppliers are expressing their support and commitment to the concept.

There are other proposals which deserve the Committee's consideration. In particular, Senator Dixon's Defense Industrial Base Preservation Act of 1987 (S.1892) would make industrial base issues an integral factor in the Defense Department's weapons buying process. Among its strongest components are the expansion of the MANTEC program throughout DoD, expansion of the industrial modernization incentives program, and the machine tool procurement provisions, which we believe should be expanded to cover critical or complex spare parts as well. This proposal should be coordinated with any legislation that results as a result of this Committee's investigations and the legislative package under consideration by the Armed Services Subcommittee on Defense Industry and Technology.

Investment in new technologies can also be stimulated by expanding markets. Our industry is very involved in export markets. We have conducted our own trade missions to China, Mexico, the USSR, Australia and India.

We help our members market to domestic customers by arranging vendor fairs across the country which are attended by representatives of the nation's 400 largest manufacturers. We are presently in the midst of a major customer education program to help domestic customers identify the "true cost" of domestic vs. foreign sourcing.

A third huge market is the U.S. Department of Defense, which buys $28 billion worth of spare parts each year. Most of those parts are procured on a sole source basis. Practically none of the sole source procurements go to small businesses. Case studies by the Small Business Administration and the General Accounting Office as well as observations by Competition Advocates are consistent in their findings: A part procured on a competitive basis (i.e. formally advertised sealed bid) costs about 40-50% less than

the same part procured on a sole source basis. With perhaps $15-20 billion of those parts purchased without using formally advertised sealed bid competitive methods, there exists a potential gross DoD budget savings of as high as $10 billion per year which could be achieved by changing spare parts procurement methods.

There are a variety of causes of the present problems which have greatly reduced the number of firms in our defense industrial base.

The government does not follow the same wise practices on behalf of its taxpayers that corporations do on behalf of their shareholders. When a small firm or inventor offers to sell a large corporation its invention or proprietary products, the large firm usually has the good sense to require in its offer that all the rights to that invention or proprietary product are purchased as well. Without those rights, the large firm that paid for the product's production would be at the mercy of the small firm or inventor. The inventor or small firm would have total control over the cost of any needed replacement parts. The inventor or small firm could set any price they wished for use of their proprietary data and could even force the large company or their customers to buy replacement parts from them on a sole source basis at whatever price they wished to charge.

In the same manner, the Defense Department should act in the interest of the taxpayer but it usually does not. Rather than paying for and acquiring rights to data needed for competitive reprocurement, it frequently accepts proposals which call for proprietary products to be included in major defense systems. The results of this practice are:

-- Spare parts horror stories, i.e. $2,000 bolts and $1,000 nuts;

-- Inability to compare competing systems, one of which may appear more cost effective on the front end, but will prove much more costly to maintain because of the subsequent sole source procurement of spare parts;

-- The constricted defense industrial base, with small business direct contracting share declining from 15.2% of DoD prime contracts in FY 1979 to 13.7% in FY 1985;

-- Declines in readiness, with many of our state-of-the-art defense systems often inoperable because of lack of affordable spare parts.

There are numerous other problems with the procurement system, most of which have to do with management practices. Our Association and nearly 200 other associations in the small business community worked hard in 1984 to help pass the Competition in Contracting Act and other needed reforms. Not all our objectives were met due to compromises in the legislative process. Still more of the potential benefits

were lost in the process of interpreting the law into regulations. All in all, while some improvement was made, there is still the potential for vast improvements and cost savings.

At this time the Armed Services Subcommittee on Defense Industry and Technology is reviewing recommendations from a Defense Industry Advisory Group appointed by the Subcommittee. The Advisory Group, representing some of the nation's largest and most prestigious defense contractors, has made many excellent recommendations. Unfortunately, it has also made some recommendations that will prove only costly to the taxpayer, especially those relating to data rights. If followed, they will lead to a further contraction of the defense industrial base, higher spare parts prices, a new round of spare parts horror stories, less innovation, and fewer opportunities for small businesses to participate in the process.

This is the wrong time for such a policy. We need procurement policies which will enhance the efficiency of scarcer defense dollars and which will broaden our shrinking industrial base rather than further consolidating it. Our recommendations to Senator Bingaman and the Subcommittee are attached. We would urge all of you to join us in our efforts to change the parts of these legislative proposals which would hurt small business, our industrial base, and our national security.

Two members of this Committee serve on both the Armed Services and Government Affairs Committee and three others serve on one of the two committees. We urge all five of you to seek a cooperative initiative with the other two committees.

Thank you Mr. Chairman. That concludes my statement. I will be happy to try to answer any questions you might have.

EXCERPTS FROM

MANUFACTURING NETWORKS AND REINDUSTRIALIZATION: STRATEGIES FOR STATE AND LOCAL ECONOMIC DEVELOPMENT

BY

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LEARNING FROM ITALY'S INDUSTRIAL RENAISSANCE

The expansion of small firm network manufacturing has been a central development policy in the region of Emilia-Romagna for twenty-five years. As a result, the region has suffered no catastrophic loss of jobs and shows no signs of urban deterioration. On the contrary, there have been substantial increases in job opportunities, explosive growth of entrepreneurial activity, and rapid improvement in the standard of living. Today, 38 percent of the regional labor force is engaged in manufacturing. Per capita income is the highest in Italy. Productivity rates are the highest in Europe.

The successful reindustrialization of Emilia-Romagna reflects a combination of factors: sophisticated business service programs, excellent vocational education and worker training systems, and active cooperation between government, trade associations, labor unions, and university research centers. The innovative industrial system created there represents a rational response to the continuing changes in markets and technologies. It is a model with enormous potential for dealing with the problems created in US states and cities by the decline of traditional manufacturing.

THE EMILIAN NETWORK MODEL

In Emilia-Romagna, the decline of mass production industry has been paralleled by a proliferation of small firms--325,000 in an area of 4 million people. Roughly 90,000 of them are engaged in manufacturing, and of these the vast majority are owned and managed by former factory workers. Their strength lies in the flexibility inherent in their multiple-use, automated machinery and their propensity to link together to perform complex manufacturing tasks for world markets. Accepting that serial production will inevitably migrate to low-wage areas, Emilia-Romagna's small high-tech firms concentrate on quality rather than quantity. In the current global economy with its rapid product cycles and fragmented markets they are doing very well.

The importance of flexible systems, motivated workers, and quality products is well-known to all observers of the contemporary manufacturing scene. The crucial contribution of the Emilia-Romagna's myriad producers to the debate on industrial policy is the concept of the production network: a network is a coherent system of small and medium size firms in which strong commercial linkages have formed as a result, for example, of sharing marketing or technolgy transfer services. The development of network ties between firms has several advantages: it permits the aggregation of production to serve large-scale purchasers,it enables small firms to cooperatively manufacture complete components and proprietary products, and it leads to important economies of scale in the provision of joint business services.

Through network participation, a firm such as FSM of Modena is able to develop and market advanced robots with a staff of sixteen. This tiny firm concentrates on system design, assembly, and testing of completed robots. Components, including the design and fabrication of sophisticated hydraulic and electronic controls, are subcontracted to specialist firms in the vicinity. In this way, small firms in Emilia-Romagna produce fashion shoes, agricultural equipment, machine tools, motorcycles, medical devices, and clothing of all kinds.

Many of these enterprises were started on a shoestring. Frequently equipment was outdated and workplaces inadequate. In the early years, some new employers sought to avoid the pension and insurance benefits to which workers are entitled under Italian law. From the union point or view, this was the return of the sweatshop, something that had to be stopped. In fact, the unions succeeded in keeping government agencies from providing assistance to the burgeoning small firm sector. However, over time the character of these firms changed, and with them the regional economy.

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* Modena provides a good illustration:

Year	Small manufacturing firms
1950	4000
1960	14000
1985	24000

In the early going, each new enterprise usually had only one or two clients, typically much larger firms. In this situation, purchasers dictated prices. There was a great deal of downward pressure on wages, and profits were minimal. The possibility of investing in modern plant or machinery was severly restricted. Hence, the unions' suspicions seemed well founded.*

In time, however, more and more small shops escaped from these limitations by developing an alternative set of ties: they learned to balance vertical connections to the big factories with horizontal linkages to other small companies like themselves. Cooperation between firms made it feasible to bid jointly on larger and more valuable contracts. Subcontracting experience led some firms to realize that the production of individual network participants could be coordinated to create complete products for industry and consumers. To begin, it was enough for one firm to take the lead in design and marketing.

Each firm could be part of two, three, or many networks, thus minimizing risk and maximizing the chances of market success. As the concept spread, firms began to gain independence from the big factories. As those producing "in conto proprio" (for their own account) reached and passed 20 percent of all small enterprises, profits and wages began to rise. In a few years they would surpass those of the largest, unionized factories. Today, per capita earnings in the region are 175 percent above the national average.

Soon the evidence of change was visible everywhere: in the quantity of modern machinery, in the quality of the new workshops that began to rise at the edges of the region's cities, and in the number of orders arriving from foreign buyers anxious to take advantage of the performance of the growing industrial districts of Emilia-Romagna.

At first it seemed that these little firms might have found a special, fortuitous niche. Additional study revealed that they had intuited a system that fit precisely with the forces that now appear to be shaping manufacturing worldwide.

INDUSTRY'S CHANGING CONTEXT

Mainstream ecnomics has been dominated until recently by the Galbraithean concept of the giant firm that achieves stability in three way: (1) its very size maximizes economies of scale in production; (2) it is powerful enough to create demand for whatever it supplies through clever marketing; (3) its high and predictable rate of profit enables it to invest steadily in the development of new products and the introduction of labor-saving technologies. These assumptions have been challenged by American industry's loss of product leadership and market share to foreign competition. And the model itself is threatened by the global availability of computer-based production machinery and the rapid segmentation of world markets.

The past ten years have seen the movement of a host of new technologies from the research laboratory to the shopfloor--CNC, CAD, CAD/CAM, FMS, CIM. What they have in common is their base in electronic data systems. What they portend, and in part have already generated, is a fundamental shift in manufacturing, ranging from how things are made, to what is made, to where and by whom it is made. They permit economies of scale in runs of one, promising a new era of product precision and customization. These technologies affect space as well as time: a complete metalworking shop can be incorporated in two or three machines occupying no more area than a suburban garage.

Difficulties in adapting to the new industrial conext thave led to a substantial decline in American manufacturing: in the last five years alone, roughly 5 million industrial workers have been dislocated. The biggest firms have been hardest hit, leading some commentators to posit a "post-industrial age," and to argue for a public development focus solely on the service sector.*

However, the service sector is not likely to provide jobs for blue collar males or minority young people who make up the bulk of the unemployed. There are also signs of trouble in the advanced services sector, e.g., banking and insurance. After a period of steady growth in New York City, employment dipped in these industries in 1985. Studies point to the comparative ease of automating clerical and middle-level managerial tasks and predict substantial job losses across the financial services sector in the next few years.

Solving the unemployment problem, revitalizing city neighborhoods, strengthening the nation's trade position, and maintaining our tradition of opportunity can only be done by rebuilding American manufacturing. However, two current articles of American faith--the indispensability of the giant corporation and the infinite expandability of the service economy--are obstacles to reindustrialization. The industrial renaissance underway in Emilia-Romagna challenges our assumptions and demonstrates the resilience of a different system built on smaller production units, diffused entrepreneurship, shopfloor cooperation, and technology-based flexibility.

University of Modena economist Sebastiano Brusco, a long-time observer of Emilian manufacturing, explains the strength of the model in these terms:

> The capacity of the Emilian model to resist competition is rooted in three main factors. First, flexibility in the use of manpower. Second, the rather high technical

level of machinery employed. It has also been possible to counteract pressure from the Third World countries by shifting production up-market.

The sectors in which decentralization is particularly marked are those in which it is possible to fragment the productive process without having recourse to an inferior technology. For example, the Morini motorcycle plant in Bologna has 100 employees and produces 20 motorcycles per day. Except for the camshaft and the engine mounting, all the components [are bought from outside suppliers]. The key point is that they are produced with precisely the same techniques that would have been used had the firm decided to make them directly. In other words, with certain technologies there is no advantage in producing all the components of a product under a single roof. Whether they produce similar or different pieces, twenty lathes have substantially the same productivity if they are gathered together under one roof or spread out under twenty roofs.

This type of industrial structure more than any other fosters the skills and initiative of its entrepreneurs. By using the foresight and imagination of so many artisans, the productive structure is able to offer an extraordinary variety of products which cleverly interpret the needs of consumers and the shifts in their tastes. Finally, the small firm's capacity to develop new products is enhanced both by the proximity of so many entrepreneurs engaged in similar activities and by the extensive collaboration between skilled workers and technicians within the firms. [Report of the World Trade Center conference, October 1986, forthcoming]

It is also true that the need to change products and processes with great frequency leads to the emergence of "operai polivalenti:" multi-skilled workers capable of progamming and running most, or even all, the machines in a given shop. This steady development of skills, coupled with a focus on quality production and minimum hierarchy on the shopfloor, provide the conditions for highly satisfying employment. For workers who move up to become plant owners--as many do, given the broad diffusion of information about markets, the ready availability of business services, and the moderate capital requirements--involvement with cutting edge technologies and with international trade fairs and export markets produces a striking level of cosmopolitan sophistication. One could well argue that the most important reason to adopt the Emilian model is not its patent economic success, but the quality of the jobs it creates and the character of the workers it produces.

GROWING THROUGH EXPERIENCE

Giorgio Fua`, an Italian economist and long-time observer of the small firm system, has written:

> The [Emilian] model has the great value of permitting the largest number of workers to create new enterprises and to grow through experience.

This model also distributes the benefits of technological advances, encourages investments in human capital, creates participatory workplaces and satifying work, offers scope for enterpreneurial ambition, and sustains blue collar employment. Before examining the transfer of this industrial system to US conditions, let's first listen to several Emilian workers who operate small manufacturing firms:

1. The owner of the Lungari Machine Shop in Modena was interviewed in his modern shop in front of several long-bed, horizontal grinding machines:

> I used to work in a larger firm. I had a reasonably skilled job. Then, partly because of ambition and partly beacuse independence suits me, I started this business. I'm happy I did. On the other hand, in the metalworking industry one needs up-to-date technology and, well, we don't get any support to speak of from the government.
>
> I do get help from the CNA, the small firm association. I'm always looking for ways to improve the business.
>
> This is a specialized shop. We do close tolerance grinding of large pieces--usually machine tools, both new and used--but also for other industries. Beween large and small firms we have about 180 regular clients.
>
> [As far as machinery is concerned] we are in the avant-garde. These are all quite new machines. The oldest I bought in 1976, others in '81, '82, and so on. It's important to keep your eyes open, to go to trade fairs, read technical journals...to stay on top of what's going on in technologies and markets.
>
> Between the shop and the office, I have ten workers here. They are all union members.

2. The COXA metalworking firm is equipped with several new multi-axis machining centers. One of the partners describes the quality of the components his small firm makes:

> This is a part for a laser therapy device. We are making a short run of them for another firm nearby.

These copper rings we make for CERN, the European Nuclear Research Center in Geneva. We have been working for them for a couple of years. They got to know our capabilities and those of other local firms following a visit we made to their headquarters. After they check our quality in their laboratories, things started going well.

This firm has twelve employees [including the three partners]. We do very specialized work. I have been here since we started six years ago. Before this, I worked for a firm which produced machine tools. The work here is different. There it was mostly one-off pieces. Here we do parts that require many specialties and materials. In many ways it's different.

I decided to become a small entrepreneur in order to develop my own ideas and to be able to work the way I like to work...and there are economic reasons. A person with a good knowledge of the field can succeed in getting a business going.

We keep up technologically through industry shows and we all regularly take courses organized by our trade association. We also use it for consulting on technical problems and management issues.

I think the future is bright. The international connections we have developed really help.

US USES FOR THE EMILIAN MODEL

The positive features of the Emilian system constitute a set of goals for the revitalization of manufacturing here. Specifically, the network model:

1. Encourages the modernization and expansion of existing small firms.

2. Naturally incubates new firms, and hence provides unusual opportunities for entrepreneurship and independence.

3. Creates jobs with incentives for skill development, satisfaction, mobility, and high pay.

4. Decreases sectoral and regional vulnerability to economic cycles and foreign competition.

5. Strengthens backward and forward linkages within industrial districts.

6. Is an appropriate response to the increasing importance of precision, custom, and technology-driven products in the American marketplace, and to the growing emphasis on out-sourcing and JIT inventory practices among OEMs.

7. Generates activities at a scale suitable to existing urban neigborhoods and hence contains the possiblity of revitalizing older cities.

The continuing deline of mass production industry, however, need not spell the demise of US manufacturing and the end of blue collar employment. The future of the American productive economy lies, at least in part, in the development of our small and medium-sized firms. On many measures, they are already doing quite well. Peter Drucker, writing in The McKinsey Quarterly (Autumn 1986), underscores the recent reversal of the dynamics of size:

> Since the early years of this century, the trend in all developed countries has been toward ever larger manufacturing plants. The economies of scale greatly favored them. Perhaps equally important, what one might call the "economies of management" favored them. Until recently, modern management techniques seemed applicable only to fairly large units.
>
> This has been reversed with a vengeance over the last 15 to 20 years. The entire shrinkage in manufacturing jobs in the United States has occurred in large companies, beginning with the giants in steel and automobiles. Small and especially medium-sized manufacturers have either held their own or actually added employees. In respect to market standing, exports, and profitability, too, small and middle-sized businesses have done remarkably better than big ones.

Other commentators, such as MITs David Birch (INC., June 1987), have stressed additional positive features of smaller firms, including high rates of innovation and responsiveness to customer needs.

The problem at present with an industrial strategy that relies on small and middle-sized manufacturers is that a disproportionate number of them are tied to the very giant firms and sectors that seem unlikely to reverse their steady decline. A necessary strategy for a manufacturing revival, then, would involve transforming today's supplier chains into flexible networks.

The case of Chrysler and its supplier firms demonstrates the economic importance of smaller manufacturers. In 1987, Chrysler's car, van, and light truck operations employ 70,000 hourly workers, most of whom work in assembly. However, the total number of manufacturing jobs involved in creating Chrysler's product line exceeds one million. These

workers are distributed over approximately 150 first tier suppliers and more than 2000 additional firms in the second and third tiers. In the first tier, average firm size is around 300. By the third tier, it has dropped to 30 or less.

And the character of these firms is changing. OEMs in general began several years ago to shift responsibility for system design and quality control downward to their suppliers who, in turn, have had to develop more sophisticated capabilities. Those supplier firms that are involved in just-in-time inventory programs will also have increased their expertise in production planning. All would be less vulnerable and might even experience a spurt of new growth if made less dependent on the auto industry.

The network potential of supplier firms--especially those in high-tech sectors--is highly significant. Consider, for example, the system of firms that has grown up around Long Island's Fairchild Republic aircraft company. Fairchild Republic has been an important producer of fighter planes since the Second World War. In 1984, Fairchild Republic contracted with 470 small firms to supply components for the prototype T-46A jet trainer. In the expectation of being part of the team in the period of regular production and of having a steady market for spare parts well into the future, Republic's subcontractors invested more than $100 million in tooling, research, and development. The, on October 17, 1986, the federal government cancelled the program and the prime contract. Fairchild Republic immediately announced the closing of the plant. Five hundred engineers and skilled workers were released outright; by year's end the entire workforce of 3000 will be gone.

As serious as this is, it is overshadowed by the impact on the firms and jobs in the supplier chain. In the aggregate, these firms employ nearly 45,000 workers. As many as 10,000 of them were directly involved in the T-46A program. Many have already lost their jobs, others are in danger of doing so. Some entire firms will disappear.

A substantial number of these supplier firms are clustered around the Fairchild Republic plant in Suffolk Country. This has two consequences: the downward uncoupling effect of the T-46A contract loss will spread deeply into the area's service businesses, causing a severe crisis at the local level; it also suggests that the affected suppliers might be organized into something resembling the production networks in Emilia-Romagna's dense industrial districts.

The possibility of maintaining basic employment and its regional multipliers is a probably a sufficiently compelling reason to focus public agency attention on threatened supplier chains. However, it is to their inherent

capabilities and potential synergies that I wish to call attention.

Fairchild Republic's component suppliers are largley grouped in three sectors: metalworking, plastics, and electronics. Their involvement in the aircraft industry strongly suggests that they are employ a high percentage of skilled workers, that their capital equipment is of the highest quality, and that they have reasonable levels of management skill. What they probably do not have, after years of functioning within the defense procurement system and close to a successful prime contractor, is a tradition of diversified product development or a strong sense of the market. As long as these suppliers continue to believe they are in the military aircraft component business they are in serious trouble. Survival and growth lie in their coming to see themselves as having broad manufacturing competence, and learning to cooperate with complementary firms to create new products for growing markets.

Once linked together through product/process design and marketing programs, these small, technically-advanced, and flexible supplier firms could make almost any product one can imagine, and a fair number one cannot. As it begins to prosper, the network they might form could create employment and entrepreneurial opportunities for Fairchild's dislocated workers.

Winning the trust of the firms in supplier chains will be the first step in turning them into networks and repositioning them in the market. As in Italy, efforts to restructure American manufacturing must be industry-driven. Government's job is ideas, seed money, and a few, convincing demonstration projects.

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CONCLUSION

The network industrial model which originated in Emilia-Romagna is steadily spreading to other regions of Italy and has taken strong root in Denmark. The fact that it has emerged in such different places underscores how well the model fits with contemporary markets and technologies and suggests that it can be adapted as a strategy to rebuild US manufacturing.

After all, the basic features of the Italian model are very much in the American grain: it stresses self-employment, the pleasure of making things, creative challenges, and a sound return on investment. We have entrepreneurial workers who could succeed as manufacturers and thousands of small and medium-size firms whose flexibility and productivity would be enhanced by close links to complementary enterprises. The development of production networks in America could well be the shortest route to increased competitiveness, more and better jobs, and healthier urban neighborhoods.

RECOMMENDATIONS OF THE
NATIONAL TOOLING AND MACHINING ASSOCIATION
ON THE REPORT OF THE DEFENSE INDUSTRY ADVISORY GROUP
OF THE
ARMED SERVICES SUBCOMMITTEE ON
DEFENSE INDUSTRY AND TECHNOLOGY
MARCH 4, 1988

1) Initiatives to upgrade the procurement workforce in terms of technical quality are badly needed. We support a Career Acquisition Management Intern program and an Acquisition Management Service Corps. The workforce, especially the competition advocacy function, should also be expanded. An expanded workforce will be able to increase the use of competition in federal procurement and would provide savings to the government in excess of the costs of that workforce. (The historical savings on a competitive sealed bid spare parts procurement versus a sole source procurement is 35-50%. Spare parts are about $28 billion worth of DoD's annual expenditures and most of the dollars are still spent on sole source procurements.) To achieve expansion and more career training in the procurement workforce, performance incentives should be offered to expand the workforce. Incentives to procurement personnel and individuals or companies in the private sector who contribute to that effort should also be offered. A share of the savings should accrue to the government in the form of reductions to the defense budget, another share should be reprogrammed and used for improving the procurement function and hiring more workers. Still another share should be used to reward procurement personnel, businesses and private individuals who have identified new vendors, making break-out possible.

For example, if one of the services is buying 100 widgets four times each year on a sole source basis for $100,000 per order, there would be significant savings if it could be broken out and competitively procured. The average price per order would be $60,000 per order for a savings of $40,000 (based on the historical average of 40% savings that result from competitive procurements). Over the 20 year life of a typical system, the savings would be $3,200,000 ($40,000 X 4 buys per year X 20 years).

We suggest that part of those savings be automatically reprogrammed to be added to existing funding for procurement and competition advocate personnel and their training. This will provide a means of expanding and improving the procurement workforce and the competition advocacy function in the face of declining budgets. In addition, we would suggest that part of the savings be programmed to provide financial rewards to procurement officers and competition advocate personnel whose success in break-out efforts exceeds the norm. Additionally, because the procurement function is presently understaffed and because savings from competition helps the defense budget and our country, we propose similar incentives to private parties, either individuals or companies, who provide information to the service branches which facilitates competition. Finally, part of the savings would accrue to the government in the form of budget reductions and/or improving readiness through additional needed spare parts purchases.

2) The market, rather than Congress, should determine the relationship between risk and reward (or profits). The

report correctly identifies many of the risks inherent in dealing with the Defense Department. For these reasons, profits on defense work by major corporations, often twice the amount of profits on commercial work, are in many respects justified in light of those risks. A GAO study revealed average pre-tax profits for defense contractors between 1875 and 1983 were 22.9%, nearly double the 12.9% pre-tax profits of automobile and other durable goods manufacturers. The same study showed manufacturers of aircraft engines and systems manufacturers pre-tax profits were 28% versus 24% for missile and space system builders. By contrast, median pre-tax profits in the tooling and machining industry were 2.6% in 1986 (1986 Industry Operating Cost Survey, National Tooling and Machining Association).

Certainly reforms which lessen those risks could represent savings for both those large corporations and the government so long as profits are also simultaneously reduced to be more in line with typical commercial profits. Efforts should be made to reduce those risks for small firms in defense contracting and subcontracting who face much smaller profit margins because a much greater share of their defense business is formally advertised sealed bid procurements as opposed to cost-plus contracts.

The government should pay 100% of the costs of special tooling and test equipment. The government should take possession of special tooling and test equipment needed for parts which will subsequently be procured competitively and should provide it for use by successful low bidders.

3) The lack of competition in defense procurement has occurred in part because there are not enough procurement personnel and in part because of inadequate technical training for procurement personnel. Competition advocates have saved far more than their cost despite the fact that they have very little, if any, authority to influence contracting officers. The authority of competition advocates should be enhanced and their numbers increased to include personnel with more engineering and manufacturing skills because of their great potential contribution to reducing defense costs.

The audit workforce also needs upgrading and better coordination. While the audit function has unquestionably uncovered many large overcharges and frauds, it is applied inefficiently to small firms. While we have had no complaints from our members over the government's right to audit their small company, we have received numerous complaints from members who have had to spend much time and money rectifying incorrect initial conclusions by inexperienced, poorly trained, and/or incompetent auditors.

Because of the low profit margins in small business (2.6% in our industry in 1986 versus 28% in the military aircraft industry), audits of small companies should be limited to

cases where there is clear prior evidence of problems and the audits should be conducted by senior, experienced personnel with knowledge of the market.

4) Restrictions on multi-year procurements should be expanded. As an example, the Air Force recently awarded a 5 year sole source contract for $2.5 billion in aircraft engine spare parts. As a result, none of those parts will appear for the next five years in the Commerce Business Daily, thwarting the possibility that prospective bidders could break-out those parts in the interim. If those parts were competitively bid individually, hundreds of small firms could have participated, saving as much as $1 billion based on traditional 40% savings. Such competitive procurement would simultaneously expand the defense industrial base. Multi-year contracts, call contracts or other euphemisms for long term sole source contracts should be a last rather than a first resort. Although there can be savings from military long term procurement contracts, historical data shows savings on long term spare parts purchases would be far less than the savings when competitive, formally advertised, sealed bid, short term procurements are used. Only when there is only one qualified contractor willing to submit a bid, should long term contracts be considered.

5) Recommendations for providing a consistent uniform government wide indemnification policy are on target. Liability costs are proportionately the greatest for small firms, many of whom cannot afford or cannot obtain such lines as product liability. Company insurance payments cover not only the costs of settlements, but insurance company overhead as well. The latter can often be nearly as much as the settlements. To the extent that the federal government provides indemnification, the overhead costs will be eliminated and small business participation will be enhanced. Thus, from a cost standpoint, indemnification is in the government's interest.

6) Most of the solutions offered in "Incentives for Innovation," "Price Only Competition," and "Defense Industrial Base and Technological Advancement" will collectively reduce innovation, further shrink the defense industrial base, raise the prices of defense systems, and lead to more spare parts horror stories. Most are precisely the wrong solutions as we enter an era of declining defense budgets.

The total cost of a defense system includes initial acquisition cost and support costs over its life. The latter costs can be substantial, as demonstrated by the $2.5 billion price tag on a recent sole source Air Force procurement for some of the parts needed to support just one model of a jet engine for five years. Failure to acquire data may lead to deceptively lower initial prices, but it will also lead to much higher (and virtually uncontrollable) spare parts support prices later. It also makes economic

comparison of competing systems proposals, one with reprocurement data and one without, impossible.

No area of procurement contains so many misconceptions as the subject of data rights. In the private sector, small companies in ours and other industries regularly sell their designs to large corporations as do independent inventors, so there is absolutely no taboo or stigma against the practice in the private sector.

In the private sector, the large company contracting out design functions simply determines whether or not it is in their stockholders interest to acquire those rights, and set its bid specifications or offer appropriately. The inventors or small companies with appropriate proprietary information who are among the potential bidders have the luxury of selling their proprietary information (at a price they set) or of developing new data at the customer's expense. No doubt many small companies and inventors would like to have the large customer disregard the interests of its stockholders and allow them to retain proprietary rights, but this rarely happens. The report suggests that the practice of requiring that proprietary data be provided will cause firms to abandon government work. In the private sector this rarely happens. Given the excellent profit margins in defense work, we think it unlikely that contractors will abandon it because the government won't let them have their cake and eat it too.

Contrary to the claim that the policy of acquiring data needed for competitive reprocurement discourages innovation, it actually enhances innovation. The companies in our industry, many of which do design and engineering work for commercial customers, rarely, if ever, refuse to bid under terms where they have the choice of developing data at the customer's expense or selling their existing proprietary data. In cases where bidders have voluntarily elected to sell proprietary rights, the companies, as a result, immediately have a renewed incentive to innovate. The customer, by contrast, having in many cases just purchased a golden goose, has less incentive to innovate and more incentive to sit back and collect significant profits on its newly acquired proprietary (and thus sole source) design.

We believe that the government should act in the interest of taxpayers just as the large company acts in the interest of its stockholders. At the front end of a major systems acquisition, all potential vendors should be told that the specifications require that the government obtains ownership of data packages and related information for those items that will subsequently be reprocured as replacement parts. Presently, ability to reprocure competitively is given weight in contract negotiations but is not mandatory.

Contractors should, of course, be allowed their choice of developing the aforementioned data at the government's expense. If they have appropriate proprietary data and wish

to sell that data to the government at a price they set, they should also have the option of including that as an option in their bid. To our knowledge, in virtually every case where it has been claimed that the government has expropriated data, the facts have turned out to be that providing the data was a contract requirement and the vendor wishes to be able to keep rights to data rather than develop new data at the government's expense or sell his data to the government. Given the subsequent profits that can be made on sole source procurements of $9,000 allen wrenches, $2,000 bolts and $1,000 washers we can appreciate their desires. However, it is not in the interest of the taxpayer nor in the interest of the defense industrial base. While we are aware of no incidence of this having happened, we agree that proprietary data should not be seized by the government, nor should the government use proprietary data without fair compensation to its owner.

There should be an exemption for small firms from the requirement that data needed for competitive reprocurement be acquired as part of the original system contract. We would hope this exemption would be supported by all organizations whose members are predominantly small firms. In many small hi-tech firms, there are only a few proprietary products and many small firms are, by virtue of their size, inherently financially unstable as well. Yet, small firms are the greatest source of innovation in this country, have the greatest capacity for surge production in times of emergency, and have a disproportionately small share of DoD procurement dollars. For these reasons those firms should be allowed to retain proprietary rights to system acquisitions to enable them to grow and contribute to the industrial base. Eventually, they will grow into large firms with the economic wherewithal to sustain continuing innovation through acquisition of the proprietary products of inventors or of small firms, and through their own R & D efforts. While this exemption would not directly benefit our industry because very few do military design or R&D, it would help many other small business industries whose members undertake much independent research and development.

Formally advertised sealed bid competition should be given priority over "negotiated" competition because it historically reduces procurement costs, and the latter should be given preference over sole source competition for the same reasons. Data on DoD expenditures should be collected separately for all three categories.

The conclusion that sole sourcing or other non-competitive procedures contribute to quality is without merit. Quality control is totally unrelated to procurement methods. It refers to the scientific and statistical methods for controlling quality on work in processes as well as the post production sampling and testing which is performed when the product is completed. The fact that so many major systems presently being procured on a sole source basis are having

quality problems shows that removing competition certainly does not guarantee quality.

However, there is in fact presently a quality control problem in defense systems. The solution lies not in procurement methods, but in developing DoD capacity to perform independent post production quality inspections in cases where quality is suspect. These inspections could be undertaken by independent contractors or military quality control personnel. Sanctions, such as nonpayment for defective parts, and debarment for consistent poor performance should be employed and should be applied in the same manner to large as well as small firms.

We believe that even a modest quality control effort of this type limited to a tiny fraction of suspect purchases would lead to major improvements in quality in defense systems and components by contractors of all sizes and product lines.

Over our nation's history, a number of legislative initiatives have led to more competition in defense procurement, with a resulting expansion of the defense industrial base. These go as far back as the Lincoln law of the civil war (intended to eliminate price gouging but which also increased competition and reduced costs) and the creation of the Smaller War Plants Administration during WWII (the same intention and also the predecessor of today's Small Business Administration). Yet, by 1980, as pointed out in the hearings of the House Armed Services Readiness Subcommittee, the defense industrial base has shrunk further: "While excess production capacity generally exists at the prime contractor level, there are serious deficiencies at the subcontractor level". . . Mr. Harry Gray, Chairman and Chief Executive Officer, United Technologies Corp., testified that "The Supplier network that forms the base of our country's defense industry is shrinking at an alarming rate. Since 1967, the number of companies involved in aerospace production has declined by more than 40 percent. In 1967, there were approximately 6,000 companies in the industry. Today there are only about 3,500."

The shrinkage has taken place among small firms and subcontractors. The large firms have continued to enjoy a larger share of a growing pie, but the defense industrial base is growing smaller at the same time the defense budgets have increased. The solution is a simple one. Increase competition and more small firms will be able to participate thus expanding the defense industrial base. Increase competition and prices will decline, getting more mileage out of an inevitably shrinking defense budget.

We also recommend the following additions to your legislative package:

1. Enact legislation requiring that government owned technical data be included in solicitations. Competition is

often frustrated because contracting officers often refer prospective bidders to DoD data repositories rather than simultaneously provide them with both the solicitations and the data packages necessary to prepare a bid. Many DoD data repositories are presently in such a bad state administratively that it often takes more than one year to get data packages from them. This is well beyond the normal 30 day bid deadline.

DoD procurement officials have stated that this would cost the government large amounts of money as data packages are costly to reproduce and bids are not forthcoming from a large percentage of respondents under current procurement methods. We believe that cases of limited responses reflect both the difficulties encountered by small firms in obtaining those bid packages as well as insufficiently detailed Commerce Business Daily Synopsis. The latter is a problem because the capabilities of a company in our industry are predetermined by an infinite variety of possible equipment configurations and quality control capabilities. Without more detailed synopsis including information, such as the approximate part dimensions, QC requirements and tolerances, companies are unable to determine whether they are equipped to produce a part until they obtain a data package. Such a requirement would force more accurate CBD descriptions in order to reduce the cost of reproducing data packages;

2. Repeal - FY 1987 Defense Authorization Act provisions raising CBD synopsis threshold from $10,000 to $25,000. Small businesses cannot compete for requirements that are not advertised in this CBD;

3. Enact legislation eliminating the presumption of CBD synopsis in the Federal Acquisition Regulations. In enacting Public Laws 98-72 and 98-369, Congress required that a solicitation not be issued until 15 days after synopsis in the Commerce Business Daily and that a solicitation remain open for at least 30 days after synopsis. This legislation was necessary in order to assure that small businesses obtain bid sets in time to bid. Congress undoubtedly meant actual synopsis as opposed to presumed synopsis.

However, FAR 5.203 permits a contracting officer to presume a requirement is synopsized ten days after it is transmitted to the Department of Commerce. This provision has been found by GAO to be contrary to law, and has resulted in requirements not being synopsized as required by law. After the provision was struck down by GAO, rather than following Congressional intent, rulemakers sanctioned business as usual by stating the presumption was inapplicable if a contracting officer had evidence that requirements were not being synopsized. This approach defies all logic. Contracting officers tell us they don't have time to see if a synopsis is published in a timely fashion, the only way they can find out is from a potential source. However, if

it is not published, the potential source won't see it and won't tell the contracting officer it was never published;

4. Enact Regulatory Flexibility Act amendment to permit judicial review of agency determinations that a rulemaking effort not subject to Regulatory Flexibility Act because it has no impact on small business;

5. Repeal the FY 1987 Defense Authorization Act provisions concerning rights in technical data. Despite the fact that DoD has wasted billions of dollars as a result of failure to acquire rights to data needed for competitive reprocurement as well as spurious contractor proprietary claims, this legislation was enacted without the benefit of hearings. It gives contractors greater claims to rights in data than they ever had before the enactment of legislation aimed at curbing spare parts abuses.

The FY 1987 Defense Authorization Act provisions also limit government data rights challenges to three years after the later of delivery of data or final payment. It would be impossible for the Services to challenge data rights restrictions in this limited time frame.

The FY 1987 provisions also provides for negotiations of data rights when an item is developed with mixed funding. Under prior law, the taxpayers obtained rights in data for competitive procurement unless an item was completely developed at private expense.

6. Enact legislation clarifying that the exception to any agency's obligation to establish source approval requirements under 10 U.S.C. 2319 is limited to the circumstances stated therein. Such provision provides an exception where the head of the procuring activity, after consultation with the competition advocate determines it is unreasonable to specify a standard. GAO has expanded this exception to include instances where low level bureaucrats make conclusory statements that an adequate technical data package does not exist. This case law should be legislatively revised since it makes 10 U.S.C. 2319 a nullity;

7. Enact legislation requiring the services to accept commercial source approval standards for spare parts, such as FAA/ PMA approval. FAA Parts Manufacturing Approval (PMA) should be sufficient for source approval. The standard for commercial use of aircraft parts is FAA Parts Manufacturing Approval (FAA/PMA approval). Despite the fact that a vendor is approved to provide a part for commercial use by the FAA, the Services will not buy from them because they do not meet their standards, which are most often non-existent;

There is no reason for the Services to require more than FAA/PMA approval of a part. Requiring the Services to penalize FAA/PMA approved parts would materially increase

competition and is consistent with the recent regulations requiring the purchase of commercial products.

8. One area of common agreement is that procurement activities are frequently understaffed with contract officers undertrained to carry out their responsibility of evaluating the qualifications of firms seeking to provide the government spare parts. Virtually every military procurement executive we've spoken to has conceded that the heavy workload of contract officers virtually precludes making special efforts to search for potential bidders on current sole source spare parts contract even though qualified firms exist in most cases and even though competition could save much money. We suggest the creation of a "competition bounty hunter" program in which third parties (i.e. not procurement personnel, prospective bidders themselves, or OEMs) would be offered a bounty of a share of the savings of contracts broken out competitively when they identify potential vendors to the buying activity. Individuals with such knowledge include many current and retired executives in our industry who are intimately familiar with the capabilities of each others shops as well as many retired federal procurement personnel. A positive characteristic of such an approach is that if successful, it would save the Services much money and if a failure, it would cost nothing.

Senator LEVIN. Thank you very much for your compelling testimony, Mr. Corner. I think what we will do is call on Mr. Costa at this time and then ask questions.

Mr. COSTA. I would like to ask that my written comments be inserted in the record.

Senator LEVIN. They will indeed.

STATEMENT OF PAT V. COSTA, PRESIDENT AND CEO, ROBOTIC VISION SYSTEMS, INC., HAUPPAUGE, NY

Mr. COSTA. This morning I will be speaking from my notes. Robotic Vision Systems, RVSI, as we are known in our trade, is headquartered in Hauppauge, NY, with additional facilities in Sterling Heights, MI.

Our annual sales in fiscal year 1987 were $14.8 million. We employ 150 people, 85 of who are in engineering. Our business is producing turnkey three-dimensional vision based robotic systems for inspection and measurement.

I am also chairman of the Automated Vision Association, our industry trade group. As such, I speak for our more than 50-member machine companies.

Both our company, RVSI, and member companies, are directly involved in the implementation of a key manufacturing technology. We serve both large and small companies. This then is a report from the front lines.

Mr. Chairman, it is heartening to see the recognition of this major problem by this committee and the willingness to work for solutions. We greatly appreciate the opportunity to share with you our experiences with DOD programs and offer our suggestions as to how we think these programs can be enhanced to better promote participation by small-sized companies in an effort to strengthen the U.S. defense and industrial base.

For those of you unfamiliar with our technology and our industry, a few words of background. Machine vision products are machines that see. They emulate the human eye-brain combination. They are more accurate. They are tireless. As such, they have many uses, primarily in inspection and robot guidance.

They can improve quality and productivity, sharply reduce scrap and rework and, therefore, costs. Perhaps their greatest advantage is they add greater flexibility to flexible manufacturing systems.

This technology was created primarily in the United States, like numerical controlled machined tools and robots. However, unlike numerical controlled machine tools and robots this is a technology in which the United States is still far ahead. There is time still to maintain that leadership position.

Our industry is made up primarily of small companies. However, we supply both small and large companies, and this is a very key point, because the degree to which our companies and our technology can be enhanced is a great point of leverage for the industrial base in this country.

I would like to propose this morning two concepts for your consideration. The first I think we can all agree on, that manufacturing technology is important and obtaining more of it is desirable.

I suggest that we have a way to promote and enhance that technology through the Department of Defense programs that are already in place. We will make some suggestions here as to how those programs can be further enhanced.

The second concept is that more important than creating technology is getting that technology into the key industries in this country. This technology must be implemented, and we will propose some ways to do that

First, programs like the Department of Defense manufacturing technology program's IMIP programs are very important in the development of technology because they directly fund the development of these key manufacturing technologies.

Our company, RVSI, has secured several of these contracts over the last several years. Our company has worked in three key areas. In our ICAMP programs, Integrated Computer-Aided Manufacturing of Propellers, we have developed a pivotal technology to improve the manufacture of submarine propellers.

Those of us who have followed the sale by the Japanese company, Toshiba, of key machine technology to the Russians, are well aware of the substantial loss that that represented.

Our company has developed an improved technology, better than that which was sold to the Russians, which represents a way for this country to stay ahead in this key area.

A second area in which our company has worked is the general area of reverse engineering. The chairman mentioned the Navy RAMP Program. There are a multitude of parts in our nation's arsenal for which there are no, or inadequate, manufacturing drawings. When these parts have to be remade this presents difficulties.

The use of machine vision is very useful. It can scan existing parts and produce CADCAM drawings which allow the remanufacture of these parts; thus, reducing cost and improving quality.

A third area in which our company has worked is in electronic inspection. We are presently working on a machine that improves inspection of solder joints on electronic circuitries. This is a breakthrough technology. It was partially sponsored through the Navy CCAPS Program in which we were a subcontractor to IBM. IBM is the prime contractor.

These programs have fostered the development of machine vision generally and have allowed our company to contribute to better weapon systems for the Nation's defense and to assist major Government contractors in improving their productivity.

We are presently delivering to General Dynamics Land Systems Division in Lima, OH, on its most major automation project. Vision-guided welding machines will be used to improve quality and reduce costs on the M1-A1 tank.

In addition, we have several major systems installed in industrial companies such as the Caterpillar Tractor Co. and General Motors Corp.

There are ways that Department of Defense programs can be improved, however, though I must note that they have been effective in our case so far.

More dollars are needed. There is in fact a bill, the Dixon bill, S. 1892, which we feel would enhance the entire program of development of technology, and we recommend its passage. The avoidance

of the erratic, year-to-year fluctuations in budgets for these programs is very important. Only in this way can small companies plan their futures.

We must reduce the contracting time. Often 2 years is required for a program to be put on-stream. Especially for small companies, this may represent 20 to 30 percent of the entire history of the small company. Improvements must be made here.

The IMIP Program, Industrial Modernization Incentive Programs, assists users of this type of technology to buy needed capital equipment and tools. The Air Force is the leader in this area. We would like to see the Army and the Navy increase their participation in this kind of program.

Finally and, perhaps, most importantly, a continued improvement in the Department of Defense strategy in this area is desirable. It seems to us from our perspective that the Department of Defense has an emerging recognition of the importance of manufacturing technology. This must continue. Also desirable is a greater level of integration between these direct funding programs and the purchase of major weapons systems.

The second concept I would like to put before you this morning is a way to get the technology into our key industries faster. This is a complex issue and many recommendations have been made this morning, most of them valid.

We must get away from the financial community's insistence on short-term objectives. We must enhance manufacturing technology in our schools. The situation in our Nation's MBA Programs, wherein most of our better minds are going into investment banking and consulting, must be changed.

Also we must have financial incentives, like tax credits and, as I mentioned, the IMIP Programs.

As our company and our industry have tried to sort through these various suggestions, one factor seems to rise to the top of the list in all of our discussions: That the senior management in user companies is the pivotal point of leverage, since only the senior managers in a user organization can control the wide range of change that is needed.

Just adding a few robots to the factory won't work. We must realize that the exploitation of new manufacturing technology usually requires fundamental change in the entire organization; product design, factory procedures, labor work rules, a different kind of marketing, and changes in the accounting system. Only senior managers have the power and, hopefully, the will to make these changes.

Our managers must understand what the Japanese companies' managers seem to understand instinctively, that only a holistic approach can work in the implementation of manufacturing technology.

If you accept this premise, it is really good news because education of managers is a manageable task and there are many ways it could be done, perhaps a Center for Manufacturing Science or similar programs that could develop a body of knowledge that can be imparted to our senior managers.

We know the key industries, the major industries that we would like to target and they can be targeted and changes can be made.

In summary then I have suggested two things. Both are manageable tasks. One, that we need to develop more manufacturing technology and there are programs in place today that can accomplish that. Two, the diffusion of this technology into industry must be accelerated, and this can be done by educating senior managers in manufacturing companies in ways to use these new technologies. Thank you for your attention.

[The prepared statement of Mr. Costa follows:]

STATEMENT

OF

PAT V. COSTA

CHAIRMAN OF THE BOARD, PRESIDENT, AND CEO

ROBOTIC VISION SYSTEMS, INC.

BEFORE THE SUBCOMMITTEE ON

INNOVATION, TECHNOLOGY AND PRODUCTIVITY

COMMITTEE ON SMALL BUSINESS

U.S. SENATE

WASHINGTON, D.C.

MARCH 1, 1988

Mr. Chairman, Members of the Committee, my name is Pat V. Costa. I am Chairman of the Board and President, Chief Executive Officer of Robotic Vision Systems, Inc. RVSI, as we are known in our trade, is headquartered in Hauppauge, NY with additional facilities in Sterling Heights, MI. Our annual sales in the fiscal year 1987 were $14,825,000. We employ 150 people/85 of whom are in engineering. Our business is producing turnkey 3-D Vision Based Robotic, Inspection, and Measurement Systems.

Robotic Vision Systems, Inc. is recognized as a world leader in the emerging machine vision industry. RVSI's proprietary three-dimensional machine vision systems effectively emulate the eye and brain of the experienced human worker and, when integrated with standard industrial robots, form a reliable, repeatable, full automated version of the human eye-brain-arm system.

The utilization of intelligent flexible automation systems such as those developed by RVSI is at the leading edge of a global trend toward improved manufacturing productivity and quality.

We greatly appreciate this opportunity to share with the Committee the experiences we have had with DOD programs and offer our suggestions as to how we think these programs can be enhanced to better promote participation by small sized companies in the effort to strengthen the U.S. defense industrial base.

The majority of our experiences with federal and/or defense programs have been with the Manufacturing Technology (ManTech) program. We have been successful in securing several programs over the past eight years.

A recent publication by the Manufacturing Studies Board of the National Academy of Engineering (NAE) titled "Manufacturing Technology: Cornerstone of A Renewed Defense Industrial Base" states:

"direct DOD funding should support process technology that:

- o requires long lead times for development.
- o is too risky - either technically or economically - for contractors to undertake on their own.
- o is critical to meeting unique defense requirements, and
- o is applicable to more than one supplier or weapon system.

Only one program in the Department of Defense, the Manufacturing Technology (ManTech) program, focuses on the long-term basic strength of manufacturing. Compared to other DOD programs,

ManTech is small. At its highest level of funding -- $204 million in FY 82 -- ManTech represented just over 0.1 percent of DOD's procurement budget. Its share has been shrinking rapidly since then. In FY 87, funding had dropped to $124 million. The current ManTech program is vital and needs to be strengthened." The study goes on to say "unless the trend of shrinking funding and diminished influence is reversed the country will soon lose not only the ManTech program, but also the primary source of direct federal investment in defense manufacturing technology development".

Mr. Chairman, those are solemn words indeed - but they do point out the problems the United States faces today in the effort to assure national security by a strong defense industrial base. The same words are also harbingers of another possible slip in the international competitiveness of our entire manufacturing community.

A major role of the ManTech program and the area where my company participates, is in the development of a new generation of smart "tools". Our loss of leadership in computer numerically-controlled machine tools (developed in the U.S. with DOD funds) is proof positive that we must be diligent in protecting technological leadership still enjoyed by the U.S. in this area. DOD has no direct charter to support the role of commercial manufacturing in the U.S.; however, DOD will be hard pressed to

meet its mission requirements without a positive and healthy U.S. manufacturing base.

The machine vision technology industry in the United States has a firm grasp on the technological lead in the international marketplace. Although non-U.S. Hitachi and Matsushita Electrical Industrial have done work on vision, they are technologically behind U.S. companies. This marketplace at this time, then, is led by small sized U.S. firms.

RVSI's experiences with defense programs lead us to believe that for smaller U.S. firms with limited resources both financial and human, DOD contracting is not for the faint in heart.

As mentioned earlier we have participated significantly in ManTech programs. The difficulties experienced by the ManTech programs as described by the NAE report transmit directly to those of us who are involved with this program. It has been frustrating to us to see the ManTech program with its critical mission being kept out of the mainstream of DOD business.

We believe that RVSI represents the excellence of the ManTech program. We are particularly proud to see the technology developed in the ManTech program with RVSI find application in other manufacturing projects - for example the welding technology developed by RVSI for the U.S. Navy Integrated Computer-Aided

Manufacture of Propellers (ICAMP) system is now being applied to the manufacture of U.S. Army tanks in the General Dynamics Lima Ohio Tank Plant. This project is General Dynamics Land System's largest automation program. When completed in mid-1988 it will provide major improvements in quality and productivity at a lower manufacturing cost.

We regret very much that budget problems in the U.S. Navy ManTech program have kept us from continuing at full speed on our ICAMP system in support of the Navy's Submarine programs. We feel that the ICAMP system embodies vastly superior technologies to those recently illegally sold to the USSR by Toshiba Machine Tool Company and Kongsberg, Vaponfabrikk.

Another program that holds great promise for benefit to small sized businesses is the Industrial Modernization Incentives Program or IMIP. This program is designed to stimulate defense contractors to implement plant modernization. In addition to normal risks associated with modernization, the defense contractor faces the risks of annual procurement and contract cancellation or modification, which can render his investment useless. The contractor also faces a low return on his investment since Government procurement policy dictates that price and profit be negotiated on the basis of cost. The result of this policy is that a plant modernization program which reduces manufacturing costs may actually result in lower profits to the defense contractor.

The Air Force has been very active in getting IMIP programs on stream. We would hope that the Army and the Navy would become more involved in order to more effectively transfer new technology to the factory floor.

We applaud the efforts of one of your fellow committee members, Senator Dixon, and others who have been working to forward the cause of ManTech and IMIP.

Senator Dixon's bill S-1892 would amend to title 10 of the United States Code and other provisions of law to maintain and improve the defense industrial base of the United States by specifying the the management responsibilities of the Under Secretary of Defense for Acquisition, encouraging investment in emerging technologies and modernized production facilities, fostering the dedicated participation of private domestic sources, and discouraging unfair practices by foreign sources.

The current state in U.S. manufacturing technology points out the need for a separate Manufacturing Sciences Program to provide basic research and exploratory research in manufacturing technology. This could be done in close conjunction with the existing DOD ManTech program.

The action that could most significantly help small sized businesses in pursuing and managing DOD programs would be an improvement of contracting practices and regulations to shorten the time that it currently takes to award contracts. Contracting officers who are accustomed to working with large defense contractors need to realize that a six month delay in contracting that would be an inconvenience to a larger contractor can be extremely punitive for the smaller sized company.

Another publication of the National Research Council - "The Role of the Department of Defense in Supporting Manufacturing Technology" states "in the DOD ManTech program the time between submitting a proposal for a directly funded development effort and receiving funds often exceeds two years". Mr. Chairman, I need not point out that two years in the life of a small sized business could be 20-50% of the company's history.

In the case of RVSI we have several times been placed in the position of fully supporting a project at expense to our other business programs while what we sorely hope will be the ManTech support wends itself through the acquisition cycle. I would repeat that this business is not for the uncommitted. Assistant Secretary Costello wrote in the Defense Management Journal - "I come from a very competitive industry, and I know first hand the pressures on managers to perform in the best interest of the company. Because the defense environment is somewhat more

complex than the non defense arena, private sector managers who must operate in that environment fall under even more intense pressure."

Mr. Chairman, I also serve as Chairman of our industry's trade association, the Automated Vision Association. Machine vision is one of the new, underutilized technologies available to U.S. manufacturers. The benefit from utilizing technologies such as machine vision can be enormous: improved product quality, greater flexibility and higher productivity. The primary goal of the Automated Vision Association is to promote the successful use and development of this important technology. It is very important to note that most of the supplies of machine vision, robotics and flexible automation systems in this country are small businesses. The primary customers and beneficiaries of the technology of the small companies are large U.S. businesses. Accordingly, it is clear that our small companies have the capacity to profoundly affect the productivity and competitiveness of our nation.

Despite our technological prowess, American manufacturers have been markedly slower in introducing automation technologies than have our competitors abroad. The capacity to generate and capitalize on new technology is clearly one of America's precious economic resources. Strengthening the ability of American business, government, and workers to create, apply, and protect that natural resource requires urgent action.

We would urge the committee to support any program that encourages U.S. manufacturers to take advantage of new automation technologies while providing proper funding for DOD programs that motivate automation of the manufacturing process by example as well as direction.

Senator LEVIN. Thank you, Mr. Costa.

Just on that last point, give us an estimate of the number of senior managers that would fall into your category, just take the number of companies that you think we are talking about and multiply it by an average number of managers. Are we talking 10,000, 50,000, 100,000, a quarter million, either one of you?

Mr. COSTA. Let's make that calculation. Certainly it depends on your premise of the number of key industries there are in this country and perhaps I could list 20 this morning.

In those industries there may be somewhere between 5 and 10 leadership organizations. Often there are fewer. For example, in the auto industry.

The number of top managers I am speaking of are the chairman of the board, the president and perhaps his staff. So he might have 5 to 10 people in these organizations.

So multiplying 20 times 10, we have 200, times, let's say, five or 10, so at the most we have 2,000. What I am saying then is that if we could change the behavior, attitudes and dedication of perhaps 2,000, 3,000 or 5,000 people in this country we would have an enormous impact on our entire industrial base. We could quibble with the numbers, higher or lower, but I would wager we would end up in all cases with a number less than 10,000.

Senator LEVIN. You have mentioned a number of changes which are needed, Mr. Corner. You talked about a total revamp on DOD procurement, I believe.

Can you be a little more specific in that regard? And then I would like Mr. Costa to refer to it, I mean to react to it.

Mr. CORNER. We perceive DOD procurement no different than commercial procurement. We believe that the time has come in this country, the time has passed in this country when we can continue on with the management philosophy that says we are going to make more parts than what the order requires because we are going to try to inspect quality in and we are going to purchase on low bid.

That's the same problem that plagues the private commercial sector. It is the same problem that plagues the automobile industry which it has made giant strides to correct.

The day of the low bid and raping the small suppliers at the expense of stockholders' incomes or purchase order cost reductions which will give promotions is over.

We must have a total understanding of what all of the unplanned costs are downstream because of the poor quality of the product that we tried to inspect quality into.

And the systems quality sampling plans in 105–D and 9858–Q, are inspect, inspect, inspect. They deal nowhere with controlling of the processes as the Japanese do which produces no bad product. If management has a cultural change where all of the process variables are controlled by statistical process control methods, you will never make a bad product, you will never have any reason to inspect, you will never have any reasons to have inventory. That is the only way you can have true, just-in-time supply.

If we look at the $30 billion plus in spare parts that is obsoleted every year in this country because of massive inventories, because of the system that says we have to inspect, try to inspect quality

into the product or component, rather than producing it right the first time by controlling the processes, that adds approximately 30 percent to every manufactured item in this country. And it is disguised in fixed expense or as unplanned cost.

Statistical process control, as I said earlier, is not new. It was invented in 1929. It was used unilaterally throughout this country to produce a standard of living that has never been equaled in the world.

When we produced the finest quality products, we had the best service. All of those things is what made this country economically the state that it was up and through World War II and into the 1950's and 1960's.

Senator LEVIN. If you get away from the low bid mentality you are doing something which is fairly fundamental here?

Mr. CORNER. Yes, I understand that.

Senator LEVIN. What do you put in its place specifically? Omit the Competition in Contracting Act. I was proudly a co-sponsor of that until your testimony. [Laughter]

Now I would like you, and by the way, I find this absolutely fascinating so I am trying to be a little lighthearted about it, but I take what you are saying extremely serious. I think both of you have put your finger on some fairly critical needs. Be specific. If we don't use low bid as our guide how do we do it?

Mr. CORNER. We must have a bidding process, but we need a bidding process that is structured around the common criteria for audit of management skills in management, a common criteria for application of technology, innovation, and statistical process controls.

We should not send source inspectors or qualifying people out from DOD to look at bricks, mortars and machine tools to see if they are painted properly. We should audit management systems to see if SPC is in place in each company.

Senator LEVIN. So that the specs, you are saying, upon which the specs which we send out include standards, the management standards, which you have identified. If we judge people in part based on that as well as price, is that what you are saying?

Mr. CORNER. No, sir. If one of the members in our company wants to do business with DOD we must stand an audit of our facilities to see if we have proper inspection equipment, which is the mentality of trying to inspect quality into the product after it is once produced, which you can't do.

Senator LEVIN. So that a low bidder that doesn't have in place those kind of management skills and those kind of quality controls is not going to be a qualified low bidder?

Mr. CORNER. Correct, absolutely, and he is not going to produce quality products, hence, his product or component will be of inferior quality and will cost an average 30 percent in unplanned cost.

One other thing that plagues our industry is the bidding process as it exists today.

Many of our people utilize the Commerce Business Daily as a source of information for contracts. It is the only source for information that we have basically for contracts that are coming out.

We, as an industry, typically get on bidders' lists at various depots or wherever the contracts are issued and we get inundated

with inquiries on those bidders' lists with a response time of 30 days.

There is no categorization based on the audit of one's facilities of what is on that bid list. We get solicited on anything. There is no systematic way to take the audit of our facilities and our resources and tie it down to products which are in our resource capability of facilities, machines, techniques, systems, and so forth.

So we just get a whole onslaught of inquiries. With those inquiries few come with adequate specifications, and the closest library for me to get specifications is 350 miles away.

So we get the bids. We have 30 days to respond. We have no specifications. We make an application to get the specification. In some cases it might take a year to get the specification, meanwhile the bid is already closed and we get a demerit for not responding. This is the real world as it exists today.

My company, you couldn't pay me enough to get on a bidders' list. I can't afford it. My fixed expense would go so far out of sight I wouldn't be competitive in the commercial market. I would have to have approximately 50 estimators and 50 design engineers interpreting specifications to be on a general bidders' list today. And that is the real world.

Senator LEVIN. We have DOD reps who are listening to this. Would you put together for us a proposal which would add to the specifications that a low bidder must meet, those management and quality aspects that you have identified?

If your association could put that together for us, I would like to circulate that to other associations, small business associations in general, to get their reaction to it because I think you put your finger on something very important and I would like to get some reaction from some related associations, small business associations.

Do you want to add a comment?

Mr. HAHN. I did want to add a comment, that is, that we were most supportive and most appreciative for your work on the Competition in Contracting Act which we strongly supported and we think more needs to be done.

The problem that we have and one where you could help increase the modernization in our industry is to take steps that would allow our members to bid on spare parts procurements, which is a $28 billion annual market.

The small business share of direct contract actions has been declining over recent years for DOD to something like 13 percent and we think we are below that amount. We would sure like to get some data on that and perhaps Mr. Costello can provide that.

The problem is that our members are excluded by a variety of techniques, one of which is not being able to get the data in a timely fashion, another of which is the Government's failure to acquire data that would be required for competitive reprocurements.

And there are a number of the raising of the Commerce Business Daily level for printing procurements and several others that prohibit the DOD from doing business with small manufacturers in our industry who ultimately make 70 percent of those parts.

Every time you can break out a part so our members can participate, the Government will save money. That is not in controversy

with what Harold is suggesting, that we get specifications for participants that require higher levels of quality, process quality control.

We support that and, in fact, we would like to see standards, qualification standards based on sound engineering principles rather than they are now, which is often based on bureaucratic whims.

You will go and apply and say you want to build a part. If you haven't made that part before, you will be told to go back and get the blessing of the prime contractor. That puts you in an awkward position, particularly if you used to be a supplier to the contract.

Our members are in the business of making parts, that they may never have made before, right the first time, every time. Here is an illustration. If he can make this part he can make a similar part.

So the restrictions that are used to prohibit people to bid on parts unless they have ever made them before doesn't make much sense in a contract manufacturing industry where the next 10 jobs that Harold or another member in our association may get may be jobs he has never seen before.

Senator LEVIN. If you would, it would be useful for your association to give us those practices of the DOD which you find to be unfair impediments to the participation of your industry and we will be happy to get back into those with Senator Bingaman, who is really the right person to handle this. I know he would be interested in that.

Give us the specifics. Give us the example. You gave us one. You told me it takes more than 30 days to get ahold of those specifications. You can order them over the phone, for instance.

We will ask Dr. Costello when he gets here what about it and he will probably say that he will want to check it out and get back to me.

In any event, if you can get us the specifics on that, it will be very helpful.

I want to move on for 1 minute. There are two things we are asking you for this morning that came out of your testimony directly. One would be for a proposal that we add to the specs, those management and quality indicators that you have identified, because you would like to share that with other associations of small business people.

The second thing would be these impediments which you have just briefly referred to with the DOD procurement process which you believe should be corrected, and we would like to get your views on those as well.

Mr. Costa, do you have any comment on the DOD part of this? You do a lot of business with DOD. What is your reaction to the testimony you have just heard?

Mr. COSTA. First of all, I would endorse many of the suggestions that Mr. Corner made. I would say our company is dealing in both the DOD Government world and we are also competing for contracts in the industrial world. I think it might be helpful for you to draw a contrast between our experience in both in the last year or two.

We, in fact, find them moving in different directions. For our Government customers we see them heading more in the direction

of trying to increase competition and, unfortunately, working more toward price as being an important issue, while at the same time we see a trend in the industrial customer base to back away from the traditional adversarial relationship as existed in the 1950s and 1960s between vendor and customers.

An example I might draw is our work recently with the Ford Motor Co. where we are providing a system that sprays a protective coating on side panels and will protect the automobiles from paint chipping that occurs when cars are traveling on the road at high speed.

This is a project which perhaps in 1960 would have been determined by who had the lowest price, and yet today we were able to win this contract while we do not have the lowest price, but we had the best design.

The concept involved here is called simultaneous engineering. First of all, Ford limited the number of vendors. Rather than making the competition open to anyone that wanted to do business, they qualified a smaller number of vendors with an intent of working more closely with each of the vendors.

We were able to work closely with Ford's engineers. We worked on our design for the manufacturing tools while Ford worked simultaneously on the manufacturing process. In other words, we were able to do simultaneous engineering.

This led to a better product for Ford, a more effective product in terms of cost-effectiveness as well. I believe that Ford achieved lower costs even though the actual price competition in the award was not the determining factor.

We would like to see similar concepts, perhaps adopted by the DOD, in securing its contracts. Perhaps fewer vendors, all of whom must be qualified, closer working relationships at all levels in both organizations and then an adaptation of the simultaneous engineering concepts to their procurements, especially where they can specify or work with the vendor not only on the product design that is being delivered to them but on the process by which it is produced in the vendor's organization.

Senator LEVIN. One last question because we will have to push along.

Mr. Corner, you made reference to the effort that you are making in your community and you talked about the State of Pennsylvania, I believe, helping out that institute and providing some of the seedmoney for the institute which uses the shared time concept.

Is the Department of Commerce also involved in that? You made very positive comments about the U.S. Department of Commerce. Are they involved in that particular effort that you identified?

Mr. CORNER. No, sir, that is the state Department of Commerce.

Senator LEVIN. Have you also talked to any Federal agency about participation in that?

Mr. CORNER. We have been in total dialogue with Dr. Merrifield and the people of OPTI and at the Bureau of Standards and others in the Government.

Senator LEVIN. Have you applied for some funding from them?

Mr. CORNER. We have applied only for a planning grant at this time, sir.

Senator LEVIN. Is that funding available? Is there a program in place for planning grants of that kind?

Mr. CORNER. No. We haven't received it if there is.

Senator LEVIN. You haven't received it, but is there a program to which you specifically apply that could provide?

Mr. CORNER. I believe that there is one, yes.

Senator LEVIN. Given the time and the fact that we want to proceed to our next panel, we just would excuse you now with our thanks and our gratitude and your testimony has been extremely helpful to us.

We are struggling to move in the direction that you have identified and will be looking for very concrete ways and will be getting back with you to react to some of the specifics as we proceed.

Our next panel is made up of Bruce Merrifield and Bob Costello.

Bob Costello is Under Secretary of Defense for Acquisition and oversees all of the DOD advanced technology and manufacturing programs. Bruce Merrifield is Assistant Secretary of Commerce for Productivity, Technology and Innovation, and has been pursuing a concept with the Department involving shared flexibility manufacturing centers. They have been referred to very positively this morning.

I don't know whether you were here for that testimony or not, but we would want you to be commenting on that. You can proceed as you wish.

Mr. COSTELLO. Senator, I have to say, this is the best team you could have.

Senator LEVIN. We know it.

Mr. COSTELLO. We have been working on these issues together even before you were so generous to confirm me.

Senator LEVIN. That was easy.

OK, Bruce, why don't you then begin.

Dr. MERRIFIELD. I would like to have my written testimony entered in the record and make a few comments.

Senator LEVIN. It will be made part of the record.

STATEMENT OF DR. D. BRUCE MERRIFIELD, ASSISTANT SECRETARY OF COMMERCE FOR PRODUCTIVITY, TECHNOLOGY AND INNOVATION

Dr. MERRIFIELD. As Dr. Costello will point out, we have over 13 million companies in this country. Only about 5 percent are publicly traded and so most of them are the invisible backbone, the real strength of our economy. Many of them, of course, are small businesses.

We currently have been creating 700,000 new businesses every year in this country against about less than 10 percent that fail each year. This is where a great majority of the jobs, that 25 million net new jobs that have been created over the last 15 years have been generated.

These same companies also are very vulnerable because of several things. One, of course, is the rapid acceleration of new technology development that obsoletes facilities and equipment before their useful lives can be realized. Life cycles in electronics already

have collapsed to 3 to 5 years. Scarcely any other industry will have life cycles of more than 5 to 10 years.

More than that, there is another factor which I call instantaneous industrialization. I went to Korea a number of months ago visiting the Dacwoo and Hyundai facilities. Any rice paddie in the world now can be transformed in 6 to 12 months to a latest state-of-the-art automated manufacturing facility with $2 an hour labor. The Koreans tell me they can under-price even Japan 30 percent on almost anything, microwave ovens, air conditioners, semiconductors, transmissions, automobiles.

But this isn't just happening in Korea. It is also happening in Taiwan, Brazil, Mexico, Indonesia, Malaysia, Singapore, India, pretty soon in China.

About 88 percent of the world's population lives in these developing countries. They can't develop next-generation new technology as we can, but they can copy anything that currently exists almost overnight.

This is their determined way to enter our markets which also is creating an enormous glut of capacity, and putting enormous downside pressure on prices and, of course, making our small- and medium-sized companies, very vulnerable.

As a result, we see the major United States problem not in innovation, as Mr. Costa was demonstrating so clearly. We have tremendous innovation in this country. In fact, we spend about $15 billion a year in basic research in this country which is many, many times more than any other nation in the world does or can do.

It has probably cost us over a trillion dollars in 40 years to build our academic infrastructure that is unique in the world. Nobody else can replicate that in any reasonable time. That is the source, the seed corn for all of the thousands of new businesses that are being created.

However, our biggest problem is in translating that new knowledge into useful things and the key barrier here is in automation of the manufacturing function. This is where we see the micro factory, as we call it, the flexible computer-integrated manufacturing facility as the answer, particularly for small- and medium-sized companies that don't have the in-house capability to put in place these facilities by themselves, but need them to be competitive with foreign subsidized off-shore production. Shared flexible computer-integrated systems can make them competitive.

This micro-factory-concept transforms the manufacturing function into a service function in which a given company buys time on such a facility to make one of a kind or thousand of a kind, essentially at the same cost of a dedicated plant, for just in time delivery, obviating a great deal of inventory that otherwise would be necessary as well as allowing immediate entry into the marketplace for a new product. The concept shifts the burden on innovation, marketing, and distribution which to where, particularly on the innovation side, we have enormous advantages.

The flexible computer integrated micro-factory is important now for survival, let alone profitable operation of our small- and medium-sized companies. We are currently working with about 20 different sites around the country.

Project Focus Hope, in Detroit, of course, is one of those, and the Meadville area is another. Once we have one of these facilities developed, as Harold Corner was pointing out, we can replicate it around the country and then satellite program it from remote locations to make similar products where needed and as needed.

Just-in-time delivery is an essential element of this concept. Again I have to emphasize that we have enormous underutilized capabilities. We also have a lot of barriers. Mr. Costa and Mr. Corner were identifying some of them.

Others that I think we ought to be aware of, of course, are first of all our antitrust laws, the National Cooperative R&D Act of 1984 allows collaborative R&D efforts up to the point of commercialization but often may not allow subsequent collaborative efforts in manufacturing, which are equally needed.

For example, Semmatech, which involves maybe 39 or so electronics companies, can now build a flexible computer-aided manufacturing facility to make 16-megabit chips but they can't operate it. A facility of that sort would be enormously valuable to small- and medium-sized companies that also are able to generate advanced semiconductor designs to be made in that sort of a system. But, its operation as a commercial facility wil not be allowed under the current antitrust laws.

So we do need to change those laws further to allow collaborative effort in manufacturing in shared manufacturing facilities. The high cost of capital is another major deterrrent to both innovation and automation and basically the rubric of our time is innovate, automate or evaporate.

We urgently need to reduce the cost of capital now to allow accelerated investments in innovation and automation. It is a critical problem.

The liability laws, and a number of regulatory barriers also need selective modification to be less anticompetitive. We need to create the best possible climate for the unique entrepreneurial capability that we have in this country to express itself.

The United States has enormous advantages over all other nations, not only in its advanced technology that comes out of our basic research, but also in the greatest depth and diversity of industrial infrastructure in the world that results from the existence of 13 million companies. We also have an entrepreneurial culture which allows us to try and fail without personal or social penalty.

The biggest pool of trained scientists and engineers in the world, 4½ million, and the world's largest market with a common language. We really have everything, if we just get our act together and get the barriers out of the way and provide incentives. Above all we need to continually catalyze the collaborative manufacturing efforts that increasingly will be necessary. That is what many of us are trying to do.

Given the budget crunch, we don't have resources to directly fund these things but by pooling resources and skills among these small businesses we can begin to get this process going, and I see that as a salvation for many of our small- and medium-sized companies. Thank you.

[The prepared statement of Dr. Merrifield follows:]

TESTIMONY OF

DR. D. BRUCE MERRIFIELD

ASSISTANT SECRETARY OF COMMERCE

FOR PRODUCTIVITY, TECHNOLOGY AND INNOVATION

BEFORE THE

SUBCOMMITTEE ON INNOVATION, TECHNOLOGY, AND PRODUCTIVITY

OF THE

SENATE SMALL BUSINESS COMMITTEE

March 1, 1988

Mr. Chairman,

I appreciate the opportunity to testify on the subject of manufacturing and automation. With me today is Dr. Jack Williams, the Director of my Office of Productivity, Technology and Innovation, and Mr. Ted Lettes, Director of that office's Small Business Technology Liaison Division.

In my opinion this is one of the most important topics upon which I have testified in my six years as a Commerce Assistant Secretary. I say this for four reasons.

First, manufacturing has represented about 22% to 24% of our rapidly growing GNP for over 40 years. It is not a declining function at all. In fact, many of the 600,000 to 700,000 small businesses that start up in our country each year involve manufacturing operations that in turn generate millions of support function jobs. Examples of these support jobs are maintenance, construction, marketing, distribution, legal, financial, clerical and communication services. Therefore, I cannot emphasize enough the critical dependence of both our economy and our national security on the health of the manufacturing function. At stake is our industrial competitiveness in the highly competitive global marketplace.

This raises the second reason for a sharper focus on this area. The worldwide explosion of technology over recent years has collapsed product and process life cycles to 3 to 5 years in electronics. Rarely will such life cycles exceed 5 to 10 years in most other industries. The result is that existing manufacturing facilities often will be obsolete before they can realize their useful lives. Moreover, the relatively high cost of U.S. capital makes it difficult for small businesses with limited assets to make continued investments in advancing technology.

A third reason relates to the fact that we, in the developed nations, with only about 12% of the world's population, have dominated the global economy for many decades. Now, however, the other 88% of the world's population in lesser developed countries are entering existing markets and capturing market share in many industries. Any rice paddy in the world now can be transformed by international construction firms in less than one year to using turnkey, latest state-of-the-art, automated manufacturing facilities, which produce goods that are competitive in price, quality and the ability to rapidly respond to changing market needs ... underpricing existing facilities in the U.S., Japan, or Europe by 20% to 30% for almost any product, (for example, microwave ovens, VCR's semiconductors, transmissions,

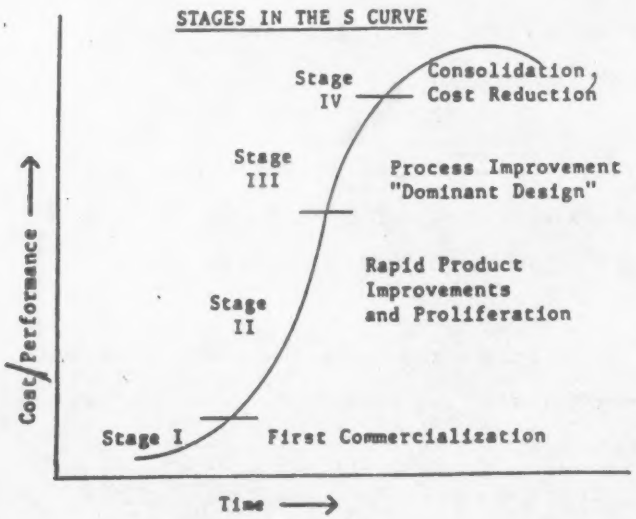
batteries). This is happening at an accelerating rate in Korea, Taiwan, Brazil, Mexico, Indonesia, Maylasia, Singapore, India, and will begin soon in China. Small U.S. manufacturing businesses cannot compete easily against this development.

The fourth reason is that there are effective solutions to this competitiveness challenge that are available now, and I would like to devote the remainder of my testimony to the concept of the "Micro Factory" or flexible computer integrated manufacturing (FCIM) facility, which OPTI has pioneered.

The shared "Micro Factory" can quickly make U.S. companies more competitive with foreign firms. With Micro Factories, manufacturing becomes a service function, where individual companies "buy time" on the shared FCIM facility to make products for just-in-time delivery, and where the unit cost in small batch productions in a flexible facility <u>is essentially the same unit cost in a dedicated plant</u>. The flexible automated facility has a longer life because it is continually reprogrammed to make new or modified products, and is periodically upgraded with new software and components. Replicated around the U.S., it can be satellite programmed to make similar products in multiple locations for enhanced revenues.

And, quality is enhanced by the automation. As you know in the Department of Commerce quality improvement is a primary objective. In that regard, Congress passed the Malcolm Baldrige National Quality Improvement Act of 1987, which President Reagan signed in August. The National Bureau of Standards, within Commerce Department, will administer this award in cooperation with the private sector.

The traditional stages of an industry's growth can freeze out new technologies and new small firms. The Micro Factory provides a mechanism that stimulates continued innovation in such industry sectors and, thereby, continuing improved competitiveness. To illustrate the relationship between our competitiveness objectives and FCIM, I have prepared a diagram:



The diagram shows four stages in manufacturing.

- In the first stage, the initial commercialization of a new product occurs, such as the automobile or the computer.

- In the second stage, many new and small firms enter the market. The scene appears chaotic. Companies develop major improvements, strengthen their manufacturing capacity, and make their products more 'customer friendly'.

- In the third stage, the more capable firms rise to the top based on dominant product designs, sophisticated process technology, and/or large marketing and distribution channels. This makes entry for additional firms difficult.

- In the fourth stage, the few remaining firms concentrate on marginal improvements to existing product lines and on reducing costs.

I could add a fifth stage--the stage where a totally new technology wipes out existing product lines or changes them in very fundamental ways.

The key point is that the technology of flexible, computer integrated manufacturing, or FCIM, has made the third and fourth stages very vulnerable, and it is in these stages where the Japanese and our newly industrialized nation competitors are particularly strong. That is, in producing large quantities of different products at low cost with well-known technology. Indeed, FCIM can actually eliminate the last two stages, greatly facilitating new small company entrants and new products. It can also provide minority manufacturing firms with a mechanism that can make them competitive in all markets. In fact, FCIM enables a company of virtually any size to enter multiple markets quickly, and to capture a large share of the global market (perhaps using a larger company's existing marketing and distribution channels), and then, and this is important, quickly develop new generations of products or make major modifications of the old ones before the rest of the world catches up.

Thus, FCIM offers major opportunities for small manufacturing firms in both product and process technologies, and in the capacity to combine those opportunities for maximum company profits. This results from initially using off-the-shelf manufacturing technology and continuously and incrementally incorporating in a module fashion new technology from both public and private sector R&D sources as it becomes

commercially available. And the FCIM centers will be continuously exploring new and more effective ways to manage businesses which use FCIM as a tool to increase their competitiveness.

Yet, the window of opportunity for our small manufacturing companies is closing fast due to very effective foreign competition combined with our slowness to react. The key point is that the survival of many of our small firms depends on rapid adoption now of existing, off-the-shelf FCIM technology, with continuous updating of successive generations of new FCIM technology.

With that thought in mind, I would like now to describe the efforts of my office in helping our small manufacturing companies make the important shift to FCIM. It is first necessary to separate the issue into two parts. The first is developing the FCIM technology itself, and transferring it to individual manufacturers or consortia of companies. This is not the role of my office. The development of advanced FCIM technologies is being done elsewhere, such as by the National Bureau of Standards, other Federal labs, and by our private sector. Nor does my office attempt to physically transfer the technology, although we are heavily involved in removing policy barriers, strengthening incentives, and providing catalytic services for such technology transfer.

The second, and equally important, part is the need to help the manufacturing community, and particularly small manufacturing firms, to become aware of the need, the benefits, and the opportunities inherent in FCIM and, most importantly, to learn how to organize and manage a company in the use of FCIM. Our experience has shown that until individual manufacturers 'internalize' this understanding, all the best technology and all the best technology transfer efforts will be useless. It is in this latter role that my office has been providing help. Some examples are as follows:

We have been catalyzing the formation of small company consortia to invest in shared FCIM facilities. Such companies are spared the full initial capital outlays for equipment and the associated difficult equipment selection process, and they can acquire training at their own pace in how the new FCIM technology works. Indeed, such facilities can also become "teaching factories". A shared Micro Factory also enables a user-company to compare manufacturing costs and the quality of existing products under the old and new systems, and to test run a new product before committing resources for internal automation.

These shared FCIM facilities are private sector driven--they are developed, financed and managed by the private sector.

They are not dependent on Federal funds. We are working with consortia of States, trade associations, other private sector groups, small and large companies, technology centers, and universities.

The National Tooling and Machining Association recently endorsed the shared FCIM concept. This association has approximately 14,000 member companies. I am told that less than 5% of small tooling and machining businesses now use automated equipment. Harold Corner, past president of the National Tooling Machining Association and currently Chairman of the Metal Trades Coalition, has presented the views of his industry with the regard to the critical need of small manufacturing firms to adopt the use of flexible manufacturing systems to become competitive in world markets.

In addition to the shared FCIM concept, we are exploring new ways of helping companies financially justify investments in FCIM. For example, we have planned a roundtable in cooperation with Arthur Anderson and Company on new accounting principles for FCIM.

We have established an interagency forum to identify opportunities for government-private sector partnerships to encourage the use of FCIM. We are also considering the

inclusion of state initiatives on FCIM in the Department's embryonic State clearinghouse program on productivity, technology and innovation.

As a result of the National Cooperative Research Act of 1984 several cooperative R&D consortia in advanced manufacturing technology have formed. We provide certain catalytic services to encourage the formation of these consortia. Since that Act was signed into law on October 11, 1984 by President Reagan, sixty-nine cooperatives have registered with the Department of Justice and the Federal Trade Commission to receive the protections of the Act. At least three of them, representing nearly 400 firms (with some duplication), are funding research critical to flexible computer integrated manufacturing. In 1985, Computer Aided Manufacturing-International (Arlington, Texas) registered; its more than 200 manufacturing companies are working in CAD/CAM research. In 1986, the Corporation for Open Systems (Vienna, VA) registered; its more than 60 users and vendors of products are funding research to accelerate the interoperability of multi-vendor products and services with a major emphasis on networking of products on the factory floor. And in 1987, the National Center for Manufacturing Sciences (Ann Arbor, Michigan) registered; this Center has more than 100 firms cooperating in the manufacturing sciences, processes and materials.

In short, efforts to encourage more widespread use of FCIM technology support:

- o existing state government efforts to diversify their economies and to strengthen existing industries;

- o enhancing the competitive position of our civilian industries, in both U.S. and foreign markets;

- o strengthening of our defense production base, which includes the objective of having critical components produced in the U.S. by our 2nd & 3rd tier contractors that have traditionally supplied 70% of the demand for components by large U.S. manufacturing firms, and;

- o beefing up our manufacturing surge capacity for use during a national emergency.

What else needs to be done? The biggest need is more effort to apprise manufacturers of all sizes, but especially smaller firms, of the need and opportunities in FCIM. This effort should not be a one-shot affair, but must be continuous. Equipment vendors, software programers, systems integrators, expert consultants, industry groups, Federal agencies, States,

major metropolitan governments and others must cooperate to raise the level of individual company awareness of FCIM benefits.

Innovative devices such as linking universities or government R&D laboratory capability to FCIM production facilities and to new business "incubators" should be explored.

Since small manufacturers rarely have the time or the money for FCIM training, local familiarization programs are needed including the establishment of shared micro FCIM centers throughout the country. Groups designed to explore the shared FCIM concept should be formed in every state.

Larger companies should have an interest in sponsoring small company efforts and, where they have a direct relationship, could help finance leasing or other ways of quickly bringing off-the-shelf FCIM technology to their small company suppliers and thereby assure domestic, as opposed to foreign, sources of parts and components.

Mr. Chairman, the U.S. has compelling advantages over all other nations in the advanced technology that comes from our $15 billion annual investment in basic research, which ultimately translates into thousands of new products, processes and

services. This investment is about 3 times greater than that of our major trading partners. We also have a unique entrepreneurial culture, the greatest depth and diversity of industrial capability, the largest pool in the world of trained scientists and engineers (4.5 million), and the world's largest market served by one common language. There is little doubt that we can be competitive in any industry if we only take advantage of continual development of "next-generation" technology combined with flexible manufacturing.

Thank you Mr. Chairman. I will be happy to answer questions.

Senator LEVIN. Dr. Merrifield, thank you. Mr. Costello.

STATEMENT OF HON. ROBERT B. COSTELLO, UNDER SECRETARY OF DEFENSE, ACQUISITION, U.S. DEPARTMENT OF DEFENSE, WASHINGTON, DC

Mr. COSTELLO. If you allow me, I will submit my written document for the record and I will make a few brief comments. It is certainly a privilege to be here.

I want to stress that Dr. Merrifield and I have been working for several years regarding small companies, small business development, and also automation.

We, in the Department of Defense, strongly believe we have an obligation as well as an economic opportunity to promote, stimulate, and encourage the vigorous participation by small businesses in the acquisition and providing of goods for the Defense Department.

Over the years it has been good business for us. The largest number of our suppliers are small business. They enjoyed last year something in the range of $27 billion worth of direct business with the Department of Defense. We look at them as providing significant input to our prime contractors.

About 40 percent of those subcontracts are also with small businesses. The quality of products at fair and reasonable prices and the satisfaction we get from the small business is key to us.

Dr. Merrifield has mentioned that we have helped them prosper; but they by far have helped us prosper as a Nation and as a Department. They have provided us with a lot of significant goods. So we want to support the activity of the Senate Small Business Subcommittee and this particular Subcommittee.

The formal statement broadly addresses broadly the focus that we have and the issues raised by the Subcommittee, but I would like to just reiterate that we do have a program on bolstering industrial competitiveness and a competitive strategy for our defense industrial base as well.

We are specifically looking at procurement reforms as they impact small businesses, looking at the development of advanced manufacturing technology.

I might just mention we have established the Defense Manufacturing Board in which we will have representation from both labor and small and disadvantaged businesses that have either been asked or will be asked as we put that board together.

We also have a number of initiatives and a significant strategy dealing with small and small disadvantaged businesses as one of the major thrusts of the Defense Department. I would like to just briefly focus a bit on the key issue of the defense industrial base.

We have conducted a study over the past 7 months and we will have the findings of that study and the recommendations of the Secretary of Defense available for review and approval shortly.

I have looked at the first set of recommendations and they weren't specific enough, so we have gone back to get specific activities defined in our presentation. It is a significant strategy for us looking at the defense industrial base and we are going to put in

place and institutionalize significant programs of an ongoing nature so that it will be a roadmap for the future.

In the area of small and small disadvantaged businesses, I think, Senator, you know personally my own commitment. As an aside, I might mention that I promised Norma Leftwich, who was formerly the head of the small business activity in the Defense Department, that I wouldn't make a speech without talking about small and small disadvantaged businesses.

I have made a lot of speeches, and I have not missed a tick on small and small disadvantaged businesses. That is one of the major obligations we have. You can count on us to continue to support all of the Congressional initiatives as well as devising our own. We look at the execution of the small business goals as a principal link in the acquisition partnership between Congress, business and the DOD. Mr. Chairman, very briefly, that concludes my remarks and I am looking forward to responding to any questions you or any of the other people might have.

[The prepared statement of Mr. Costello follows:]

STATEMENT OF

HONORABLE ROBERT B. COSTELLO

UNDER SECRETARY OF DEFENSE, ACQUISITION

BEFORE THE

SUBCOMMITTEE ON INNOVATION, TECHNOLOGY, AND PRODUCTIVITY

COMMITTEE ON SMALL BUSINESS

UNITED STATES SENATE

0930 A.M. MARCH 1, 1988

ROOM 428A

RUSSELL SENATE OFFICE BUILDING

INTRODUCTION

Mr. Chairman, I appreciate the opportunity to testify before the Subcommittee on Innovation, Technology, and Productivity. We strongly support small businesses because they provide almost forty percent of DoD's materiel and services needs. We must insure that our small businesses remain healthy and continue to contribute to our national defense.

This morning, I will address several areas related to small business. First we will discuss some of the preliminary results of a recent DoD industrial base study. Then I will cover some of the procurement reforms we have initiated to improve our relationship with small business. I will then comment on the development of advanced production technology and how some small businesses have been involved and will also describe some domestic technology transfer efforts potentially useful to small companies. Finally, I will discuss some initiatives and accomplishments of our Small and Disadvantaged Business Utilization Program.

STRATEGY TO BOLSTER INDUSTRIAL COMPETITIVENESS

We have been addressing problems with prime contractors on a broad front for some time. Our Strategy to Bolster Industrial Competitiveness was undertaken because of DoD's concern about the health and vitality of defense sub-tier contractors. We have gained some valuable insight. I will discuss two key observations.

NEED FOR COOPERATIVE EFFORTS

First, effectively dealing with the quality and productivity issues of the sub-tier community of this nation will take cooperative and concerted efforts both within industry and jointly between industry and government. Neither can be fully successful alone. The message is not new, but its implementation could have a profound effect. The defense community has not taken full advantage of the synergy possible from an effective, supportive industry and government relationship. Establishing this cooperation is an important goal.

NEED FOR CONTINUED TOP LEVEL DOD SUPPORT

Second, DoD needs a sustained, high-level commitment to deal with industrial base issues. Historically, interest flares up and then and dies down before significant action is effective. Many of the specific action items of our strategy for bolstering

industrial competitiveness are aimed at institutionalizing mechanisms to maintain long term, effective activity. We are establishing an infrastructure to: 1) recognize problems earlier; 2) develop a full range of DOD alternatives to solve these problems; and 3) seek the support of the Executive and Legislative branches for implementing effective solutions.

DEFENSE MANUFACTURING BOARD

One of our firsts steps was to establish a Defense Manufacturing Board (DMB) modeled after the Defense Science Board. We believe it will provide a forum and a communications mechanism for industry to identify barriers to quality and productivity improvement and to develop cooperative solutions. The DMB will guarantee that subtier contractor views are heard.

OTHER ACTIONS

We are also working on efforts for:

a) developing a defense industrial strategic plan supporting our military strategic plans (Additional DoD industrial assessment analytical capability will be required.);

b) implementing a long term program to provide highly qualified industrial technical people for the next two decades (Government, industry and academia will have to cooperate.);

c) improving the producibility of DoD materiel (This should enable a broader base of industry involvement.); and

d) strengthening our manufacturing technology development efforts.

PROCUREMENT REFORMS

We are also looking at what can be done to improve our relationships with our contractors - including our small contractors.

NEED FOR STREAMLINING REGULATIONS

Today, there are just too many government regulations. Our procurement system has gradually grown and grown. More laws and more rules were intended to ensure that our contractors are treated fairly and that the government does not enter into less than perfect contracts. These goals are laudable. But, we have paid a price. Our procurement system is terribly cumbersome, constrained and slow. The detailed rules have prevented contracting officers from applying their best judgment. Industry's non value-added workload has increased.

In order to alleviate this problem, DoD has involved 36 test sites in a pilot, regulation-streamlining program. They are identifying unnecessarily complex and restrictive procurement regulations and have already brought about 82 deviations to the FAR or DFARS and 15 permanent changes have been proposed. More streamlining is expected.

DEVELOPMENT OF TECHNOLOGY

DoD's basic policy is to rely on the private sector whenever possible; but we often have needs beyond the risk of the private sector. Some process technology is developed under each weapon system program but the principal focus for developing manufacturing technology is the Manufacturing Technology Program (ManTech). ManTech steps in when the private sector is either unable or unwilling to meet DoD's requirements. It develops first-case, factory floor applications of advanced technology. ManTech has had many success stories.

The Parson's Corporation, a small business, started the numerically controlled machine tool industry under a ManTech contract for developing an economical method of producing high performance aircraft. Today, the industry spans the globe and is essential to both military and civilian sectors alike.

More recently, a small California firm, Sharpe Precision, developed a machine for DoD which removes the lids from hybrid circuit cans. For the first time, the circuits can be repaired. Previously we had to throw them away at several thousand dollars each. Sharpe Precision has now provided over 100 machines to industry. DoD's benefits are estimated in the hundreds of millions of dollars.

We currently have an Air Force $9 million, 3 year initiative underway to develop advanced factory floor hardware and software for lower tier contractors who cannot afford the staff necessary to develop such technology. The Machining Initiative for Aerospace Subcontractors (MAIS) is being run by a small company prime contractor, Dravo Automation Sciences. Several small subcontractors are serving as testbeds for the technology. They are developing an unattended machining cell under the direction of a major US machine tool builder and four subcontractors are working on a manufacturing planning and control software package

suitable for smaller companies. All of the technology will be available to lower tier subcontractors.

ManTech was funded at $156 million in FY 88 ($11 million less than requested). We are requesting $172 million in FY 89. There are also manufacturing technology related efforts in other budget lines, including the Defense Advanced Research Projects Agency.

DOMESTIC TECHNOLOGY TRANSFER

Domestic technology transfer is a major ManTech goal. The ManTech program sponsors about 100 end-of-contract briefings per year. The contractor must tell other contractors what was accomplished. An annual list of topics and meeting dates is prepared each January and is distributed to over a dozen industrial societies and associations for secondary distribution to their membership. We encourage small companies to request an invitation to these meetings.

TECHNOLOGY INFORMATION PROGRAM

ManTech also participates in the DoD Technology Information Program and has a centralized repository for all research and development technical reports at the Defense Technical Information Center (DTIC). All ManTech technical reports are sent to DTIC. They are microfiched for permanent storage and easy access. Any small US company can get them for a nominal sum (subject to normal national security classification and export control regulations).

In effect, DTIC is a large technological library of DoD sponsored research and development. As with all libraries with huge collections, specialists are needed to find the information. DoD has established focal points in 21 technical subject areas to assist in finding, collecting and analyzing DoD's technical information. They are called information analysis centers (IACs) and are somewhat analogous to "reference desks" in large libraries.

MANUFACTURING TECHNOLOGY INFORMATION ANALYSIS CENTER

The Manufacturing Technology Information Analysis Center (MTIAC) specializes in manufacturing technology. The operating contract was awarded as a small business set-aside. The MTIAC shares the centralized data bases with the other centers but can also utilize commercial data bases. The MTIAC will respond to industry's queries for manufacturing technology for an affordable fee. It recently compiled an eleven volume index of all DoD

sponsored research completed in the past 10 years which might be of use to the US machine tool industry. This set was provided to the National Machine Tool Builders Association (NMTBA) for secondary distribution as part of President Reagan's commitment to help this industry. Most NMTBA members are small companies. The MTIAC also has completed several state-of-the-art reports on such subjects as: "Higher Order Languages For Robotics" which is an important reference work for industrial robot users.

TECHNOLOGY IMPLEMENTATION

"You can lead a horse to water but you can't make him drink" is applicable to the implementation of advanced technology. Because many factors control technology implementation, each company must be motivated to do so consistent with its own agenda.

The DoD Industrial Modernization Incentives Program (IMIP) is the DoD's principal activity targeted at motivating DoD contractors to modernize. The IMIP is primarily a management initiative to utilize contracting instruments that will equitably reward contractors for trying to be more efficient. The IMIP focuses initially on and can provide some funds for planning the modernization of industrial facilities used to manufacture DoD materiel. Ultimately, the contractor must invest in the capital equipment but then shares equitably in the benefits realized when that facility produces better, lower cost DoD materiel. With an IMIP agreement, the contractor no longer loses equitable profits when improved productivity reduces costs. Both parties share the benefits.

The IMIP has focused mainly on prime contractors until recently. General Dynamics is administering the Air Force's initiative to reach lower tier companies. Thirty-eight lower tier companies are involved. Six are small businesses; and a Florida small disadvantaged business may join this group.

SMALL BUSINESS A KEY

Small businesses are a key element of our industrial base. They enhance mobilization readiness and provide quality products and services at fair and reasonable prices and consistently deliver on time. The following statistics demonstrate the importance of a strong and viable small business community:

1. nationwide, ninety-seven percent of all businesses are small (13.2 million enterprises);

2. small businesses account for 48 percent of the non-farm gross national product; and of particular significance,

3. small business, not large business, created two out of every three new jobs in the last ten years.

OUTSTANDING YEAR IN SUPPORT OF SMALL BUSINESS

Very few big businesses actually produce their entire product. Our prime contractors, whether it's for the M-1 battle tank, the F-16 fighter aircraft or the Trident submarine, are all heavily dependent upon a strong small business infrastructure. Thus, one of our key acquisition strategies is an aggressive and committed small business program. Small business firms will continue to receive a fair share of the DoD's requirements for products and services. The Department is committed to it. I am personally committed to it.

During this past fiscal year (FY 1987), we awarded $26.6 billion or 19.7 percent to small businesses out of the $135.3 billion in prime contracts awarded. Since FY 1981, this rate has ranged between 18.8 percent to 20.4 percent. DoD has been able to maintain a steadily increasing level from 18.8 percent in FY 1983 to 19.7 percent in FY 1987; notwithstanding that most of the budget increase over those four years was for major weapon systems. This amounts to an increase of $1.2 billion to the small business community.

AGGRESSIVE SMALL BUSINESS SET-ASIDE PROGRAM

The DoD has an aggressive small business set-aside program, which emphasizes two major points:

1) If the contracting officer has a reasonable expectation that offers/bids will be received from two or more small business firms, the requirement must be set-aside exclusively for small businesses. This approach has been accepted for Federal Government-wide use.

2) If we purchase something successfully as a set-aside, then all future procurements for that product or service will be set-aside. This is our repetitive set-aside program.

These two criteria resulted in DoD set-asides being increased from 7.2 percent in FY 1980 to 10.6 percent in FY 1987. Set-asides now represent half of our small business awards. Set-asides are the underpinning of our entire small and small disadvantaged business program and serve as a watershed of

providing requirements for the small disadvantaged business program.

SMALL BUSINESS SUBCONTRACTING PROGRAM

Our subcontracting program is another excellent opportunity market for small and disadvantaged business. Small businesses receive awards from DoD both directly as prime contractors and indirectly as subcontractors. Last year, these were respectively $26.6 billion and $21.6 billion (40.6% of $53.1 billion) for a total of $48.2 billion on a combined basis. This is the highest level since our small business program began in 1953.

SMALL DISADVANTAGED BUSINESS PROGRAM

DoD is dedicated to attaining the Congressionally mandated goal (P.L. 99-661) of awarding five percent of its prime and subcontract awards to small disadvantaged business, historically black colleges and universities and other minority institutions. DoD can pay a premium of up to ten percent in order to make an award to a small disadvantaged business.

During this past fiscal year, we awarded 2.5 percent in prime contracts to small disadvantaged business. We are committed to achieving our goal of 5%. DoD's challenge is to find many more capable small disadvantaged firms to satisfy our product requirements. We are working very aggressively in this area and anticipate improved results in 1988.

We will soon be holding 17 conferences throughout the country to inform small disadvantaged business firms on how to do business with DoD. In addition to oral presentations, there will be one-on-one counselling sessions. We will also identify the more promising small disadvantaged businesses and provide technical assistance at their place of business. We are establishing a program to review our procurement award data to determine: a) how many small disadvantaged businesses participate; b) if they are bidding competitively; and c) what obstacles may prevent greater participation. All of these efforts will be performed by minority contractors.

We will also increase our interaction with our major prime contractors to improve their performance.

SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Another major DoD initiative is the Small Business Innovation Research and Development (SBIR) program. We offer "seed" money to

small research and development businesses to exploit their innovative capabilities to solve difficult DoD research and development problems. During the past fiscal year, we published a list of 889 topics in need of solutions and received 7,536 proposals. A total of 1,254 or 16.6 percent were selected for negotiation. This is a fantastic rate.

SMALL BUSINESS AS COMPETITORS

We are especially proud of the competitiveness of our small business community. Of the $26.6 billion awarded to small business last year, $23.2 or 87.1 percent was awarded competitively. When given a chance to participate and a chance to compete, most small businesses will provide a satisfactory product at a fair and reasonable price. And they will deliver it on time. Considering that DoD completed 8.9 million contract actions with small businesses last year, we feel we are pursuing an aggressive and viable program. Small businesses are excellent producers.

CONCLUSION

The Secretary of Defense, the Deputy Secretary of Defense and I consider small business programs as high priority programs and will continue to provide public support for them. We recognize that maintaining a healthy, robust industrial base is a key national goal and that maintaining a healthy, robust small business community is essential. Both are key to deterring war; and being prepared to fight should deterrence fail.

Senator LEVIN. Thank you, Mr. Costello.

We have just heard from representatives of the National Tooling and Machining Association. They have got some recommendations which they just handed to me relative to defense procurement which we will duplicate and get to you and it would be appreciated if you could get us a response as well as Senator Bingaman, who I know is very much in the lead of these kinds of possible procurement changes.

But while I see that in front of me, I just want to make reference to you, and I don't need a response now.[1]

Mr. COSTELLO. We look forward to getting the document and responding to you.

Senator LEVIN. We did hear today from Mr. Corner a number of problems that his colleagues in the machining and tooling area have faced in the defense procurement area and we will summarize those for you as well and get those to you for a response.[1]

I have been involved in defense procurement. Of course I am very much troubled when he tells me that they can't get the specs in time to even bid. He is 400 miles, I think he said, from the nearest center.

I am wondering why he can't make a phone call to get those specs, but we will put those into a list for you and get your response for those for the record as well.

Dr. Merrifield, you have indicated that we should amend the antitrust laws to permit for a collective effort in the area of shared manufacturing. We have done it now for R&D, and we have heard here today whether we should go beyond that.

Have you discussed any particular proposals in this area with the Antitrust Division of the Justice Department? Do you have a reaction from them?

Dr. MERRIFIELD. Yes, and what we would like to do is see the Cooperative R&D Act of 1984 just modified to include shared ownership and management of flexible automated manufacturing facilities. In fact, this is part of the legislative superconductivity legislation that has been proposed by the Justice Department and the administration.

Hopefully we can get something like that through. I think it is much more important than we realize.

Senator LEVIN. So they are supportive then of that amendment?

Dr. MERRIFIELD. Very much so.

Senator LEVIN. Do you know whether or not the Judiciary Committee has focused on that part of the proposal at all?

Dr. MERRIFIELD. I don't know that.

Senator LEVIN. That is something we can do with our colleagues on the Judiciary Committee. With your help and cooperation, we can get them to focus on this particular impediment to the Department of Commerce implementing this shared program that you have identified here and that the witnesses on the first panel indicated would be so helpful to us, so we will work with you on this.

You have also made reference to the reduced cost of capital for accelerated investment in automation. Give us the specifics. How

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[1] Material not available at time of going to press.

do you accomplish that? Are you talking about amendment to the Tax Code? Are you talking about SBA targeting some of their loans? Tell us what you have in mind.

Dr. MERRIFIELD. Again, I think the SBIR Programs are going to be very helpful here and the Department of Defense program is focused, has been focused in this area, particularly for the minority groups that really don't have access to that type of funding.

Senator LEVIN. You were talking much beyond that. You were talking about the reduced cost of capital for accelerated investment in these efforts, period, regardless of by whom.

I am wondering if you can tell us what that is going to take. Is that a new tax provision? Is that an SBA targetting? What is involved in that across the board?

Dr. MERRIFIELD. There are many ways to do that, but it would seem to me that the least interventionist method would be specific tax incentives that would be focused on productivity, improving investments in innovation, and automation, where our advantage lies. That is where we need to focus our efforts.

Senator LEVIN. We are now going in exactly the opposite direction of 2 years ago, the tax reform. Are you optimistic that we will be able to reverse that? I was not a supporter of tax reform so you can tell me anything you want. It won't shock my ears.

One of the reasons I opposed that bill, as a matter of fact, is exactly for this reason, it is eliminating a tax credit on innovative investment, innovative technology investment.

Is this something which is just really a vague hope or is it some realistic possibility that we can at least in a targeted way provide some sort of tax incentive for people who are willing to invest in advanced technology for manufacturers?

Dr. MERRIFIELD. I think it is not just a hope, although it currently may not be timely because of the budget crunch, but I think we will get beyond that before very long. I think the economy is going to continue to produce tax revenues through growth that will diminish the budget deficit concern. The economy created 3 million net new jobs last year, which probably will add $15 billion in tax revenues this year that weren't there last year.

So I think over a period of a number of years, the budget deficit problem will be minimized and as that happens I hope that we will be ready at the appropriate time to provide the incentives for this type of innovation and automation that are essential for survival.

If we don't do this we may not be competitive in the global economy as other nations subsidize their industries and use predatory pricing to capture existing businesses. Our competitive advantage rests with our ability to innovate, to create new businesses, and with automated manufacturing facilities, particularly for our small- or medium-sized businesses.

Senator LEVIN. What is the status of your proposal for shared manufacturing?

Dr. MERRIFIELD. Well, currently we are working with about 20 different entities in about 15 States around the country.

Senator LEVIN. Is there seed money for anything here? Mr. Corner, I asked him whether or not he applied. He said yes, he applied with the Department of Commerce for a planning grant, I believe.

Dr. MERRIFIELD. That was an Economic Development Administration Planning Grant. Hopefully that might be cleared shortly. I know that Orson Swindle, Assistant Secretary for EDA, is very much interested in this area where his guidelines apply, namely in disadvantaged areas. That is a different office, though, and I don't have any control over that.

Other than that, there aren't any funding sources in the Department of Commerce.

Senator LEVIN. Is that a budget issue also, in other words, if you had your druthers you would have a program for that?

Dr. MERRIFIELD. I think at least seed funding to help with the organization of these things, provide the planning grants as the EDA may do for the Meadville operation.

Just getting started is the hardest part. Once the consortium is formed with a plan and a program and an integrated organization is developed, the rest is not that difficult. But that is the biggest problem.

Senator LEVIN. Have you asked the OMB for money for funding for this kind of a program? Is that an annual budget request that comes out of Congress? What is the status of that?

Dr. MERRIFIELD. There has not been a request for funds.

Senator LEVIN. Why not? Do you know the money isn't there, it is just a waste of time?

Dr. MERRIFIELD. I believe so, yes.

Senator LEVIN. If you thought there were a possibility, you would be pushing that with the OMB?

Dr. MERRIFIELD. I think that would be an important objective; that's right.

Senator LEVIN. Can you send us some material on this, that proposal that you have not forwarded to OMB because you don't think there is any realistic prospect of it being funded? Can you get us any such documentation so at least Congress can take a look at it?

Dr. MERRIFIELD. We can provide the backup rationale for this.

[Material follows:]

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Productivity,
Technology and Innovation
Washington, D C 20230
(202) 377-1984

The FCIM-Micro Factory
Flexible Computer Integrated Manufacturing

Office of Productivity
Technology and Innovation

March 1988

The "Micro Factory"

Abstract

Rapidly advancing technology has collapsed product and process life cycles, formerly measured in decades, to less than five years in many industries, obsoleting existing equipment and facilities long before their useful lives can be realized. As a result, many small second and third tier U.S. manufacturers that supply about 75% of the components and subsystems for major contractors, have become progressively less competitive against low cost, high quality offshore production.

However, shared flexible computer integrated manufacturing (FCIM) facilities now are being developed by consortia of small business. These FCIM "micro-factories" have much extended lives, since a given facility can be continually reprogrammed to make new or modified products, but still retain some of the economies of scale of a dedicated plant. High levels of reproducibility and quality control also can result for production runs of a few or a thousand of a kind as needed for just-in-time delivery.

Similar "service function" facilities can be replicated almost anywhere in the world to make identical products as and where needed. Service function manufacturing also will lead to modifications of current concepts of economic nationalism and international trade. Both national and international strategic alliances likely will proliferate to take advantage of this new industrial revolution. Formation of multiple new businesses, in turn, will accelerate expansion of the global economy.

Binational cooperative research and development agreements now operating between the United States and France, India, Israel and Ireland currently are developing hundreds of new joint venture businesses that can take advantage of simultaneous production in worldwide micro-factory installations. These binational strategic alliances will proliferate as additional arrangements, now in progress, are consummated.

U.S. investments in FCIM micro-factories can be accelerated by removal of unnecessary liability and regulatory law barriers, by reduction in the high cost of U.S. capital (two to three times higher than Japan and other countries), by strengthened process patent laws, and by provision of specific incentives for these productivity-improving facilities.

Micro Factory Networks

Recent advances in robotics, electronics, software, sensors, and computer-aided design and manufacturing have made possible a new industrial revolution. The heart of this revolution is the flexible manufacturing plant, or core production facility, that can run virtually 24 hours a day, but with short product turnaround times and can make a great variety of specialty products. As a result, economies of scale can be achieved for short production runs, together with adaptability to changing needs, and improved quality control that otherwise could not be possible:

- The shared use of a common facility by multiple firms for multiple products reduces individual investment risks, and provides a higher return on investment for a flexible facility.
- Inventory costs can be greatly reduced because just-in-time delivery becomes feasible.
- Automated manufacturing allows improved and consistent quality control and reproducibility.
- Production can be continually adjusted to changing needs and to new products largely by software reprogramming.
- High entry costs for new product manufacturing can be greatly reduced because a dedicated plant operating at partial capacity is no longer required.

The "Micro Factory"
Flexible computer integrated
Manufacturing (FCIM)

Perspective

A worldwide explosion of advanced technology has created about 90% of all scientific knowledge just in the last 30 years. This knowledge base likely will double again in the next few years, obsoleting existing equipment and facilities long before their useful lives can be realized. Life cycles in electronics already have collapsed to 2 to 3 years, and life cycles in other industries rarely will exceed 5 to 10 years. As a result, major investments in "dedicated" manufacturing facilities now often require a hurdle rate for return on investment, that makes such investments unattractive, compared with offshore foreign subsidized production employing low cost labor. Small second and third tier U.S. businesses that supply about 75% of the components and subsystems for large contractors have become particularly vulnerable. Moreover, continued U.S. industrial competitiveness increasingly will be dependent upon survival of this small company substructure.

However, U.S. manufacturing can maintain global competitiveness through accelerated investments in flexible computer integrated manufacturing (FCIM) systems that have an extended life, and that can be continually reprogrammed on a random basis to make new (or modify old) products. FCIM "micro-factories," shared by consortia of small businesses, already are being put in place for this purpose.

These shared FCIM facilities can provide almost immediate market entry for new products requiring low-volume, short-run production. Moreover, they retain the economies of scale and reproducible quality control of a dedicated mass production facility. Once developed, similar facilities can be replicated in almost any other desired location to make identical products as needed.

Micro factories in the United States, located at universities in combination with new business innovation or "incubator" centers, also can operate as teaching facilities for engineers, scientists and business school students who will design, build, and manage them. This training function will be critical to the success of such ventures. A key element of this training is concerned with the total management of a manufacturing business using FCIM systems as a tool. All elements of the business must be integrated in cross discipline management teams for the information to be used most effectively.

- Micro factories associated with colleges or universities can provide the hands-on specialized skill training for engineers, technicians and business school students who will manage and operate these facilities.

- Decentralization of flexible manufacturing centers can promote regionalized economic development where this has not been possible before. State or local subsidies could facilitate this process.

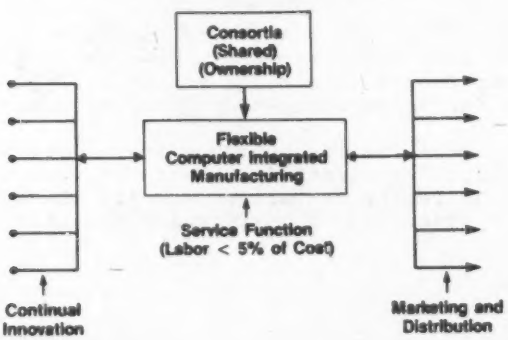
- Flexible manufacturing institutionalizes the management of continuous change that will be necessary for industrial survival.

From a national security point of view, creation of decentralized networks of such facilities is an important objective. In a national emergency such facilities would provide standby capacity for rapid reprogramming to meet military surge needs, as well as sustained capacity if required. This would eliminate the need for costly, redundant but idle capacity, together with portions of the current $100 billion military stockpile and parts inventories. Also, such facilities, if partially base-loaded in peacetime with relatively low military needs, could further improve the return on investment for commercial purposes.

Decentralized FCIM micro-factory networks would provide immediate low cost entry into the marketplace for a continual stream of new product developments, and the capability for their continual modification as desired (EXHIBIT I).

EXHIBIT I

THE NEW INDUSTRIAL REVOLUTION

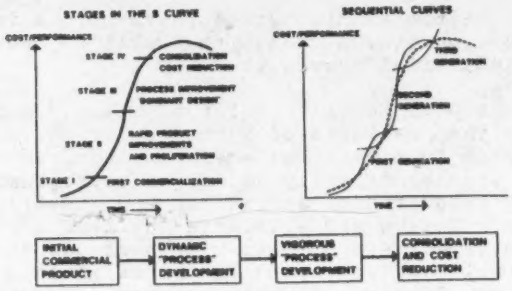


These service centers, which are located adjacent to universities also will provide hands-on education and training for engineers, technicians and business school students, although the facilities themselves are owned and operated by consortia of industrial firms.

Previously, the life cycle of a product usually has passed through four stages: (EXHIBIT II)

EXHIBIT II

S-CURVE LIFE CYCLE STAGES



- The first stage involves the initial commercialization of an innovative concept that may have originated from a fundamental discovery in a university or government laboratory.

- A second stage of dynamic "product development" then follows in which many competitors also enter the market with variations of the new concept.

- The third stage sees the emergence of a "dominant design" that freezes further major product improvements, and ushers in a stage of rapid "process improvement, as a few larger companies begin to dominate the market.

- Finally, in the fourth stage, a few remaining companies share the market for a product that has lost most of its proprietary character, and for which only incremental improvements in quality and reduction in costs are made.

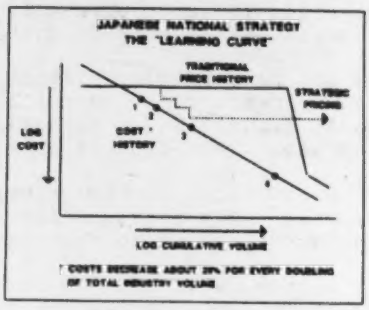
The Japanese "targeted industry strategy" initially was focused on the last two stages, taking advantage of obsolescing U.S. manufacturing operations to introduce automation and better quality control and capture market share with predatory pricing (EXHIBIT III).

EXHIBIT III

TARGETED INDUSTRY STRATEGY

STEPS

1. CONCENTRATE HOME MARKET
2. SHARED R&D
3. 80% LEVERAGED
4. CLOSE OFF IMPORTS
5. TWO TIER PRICE
6. EXCHANGE RATES
7. EXPORT SUBSIDIES



However, the FCIM micro-factory will tend to obsolete stages III and IV where U.S. companies have been weak, and provide an important advantage for those U.S. companies that are generating leading-edge, next-generation technology.

The United States currently spends about $15 billion each year in basic research, many times more than any other nation spends or has the in-place academic capability to spend. This unique advantage has resulted in possession of the world's most advanced automated equipment and computer integrated manufacturing technology. Moreover, because of ongoing research, the lead likely can be maintained for the indefinite future.

However, except for a relatively small group of large companies, advanced manufacturing technology has not yet been widely used. It remains largely in our laboratories, although the Japanese and others have been capturing it for their own use. Widespread U.S. development is hindered by lack of understanding, of its importance, lack of skills, lack of access to low cost capital, and lack of tolerance for risk by hundreds of thousands of small and medium-sized manufacturing companies.

A New Management Culture

The U.S. is unique in its proliferation of small businesses in an entrepreneurial culture that continually creates leading-edge technology. Urgently needed is access for these companies to flexible computer integrated manufacturing (FCIM) "micro-factory" centers to take advantage of such new developments.

Moreover, this concept represents a fundamental change in strategic management culture, both on an individual company level, and also on a state and local level.

- It permits and promotes economic development and job creation in geographical localities where such activity has not been possible in the past.
- It allows continuous incremental adaption to changing requirements for products and systems that otherwise would require major retooling and down times, and it represents the epitome in market-response, as a result.
- It allows just-in-time manufacture and delivery thus substantially reducing the costs of inventory but with instant response to customer needs.
- It allows rapid and low-cost state of the art manufacturing for new products while market demand is being built but without the need for up-front capital investment.
- Investments in shared facilities to meet the needs of multiple firms are likely to lead to more efficient use of capital by avoiding overinvestment in specialized, dedicated facilities.
- Coupled with local incubator centers, industry and universities, it could provide "real world" engineering training together with facilities for reskilling of the work force, and for commercializing university-owned technology.
- It could evolve into the ultimate support function for entrepreneurial new-business development, and for lifelong continued reeducation, providing a magnet for entrepreneurs as well.

- Local banks and financial institutions could find a direct and personalized role in the entrepreneurial process, with a resulting reduction in risk for their capital investments.

Barriers to Flexible Manufacturing

Both national security and economic survival of many U.S. businesses require major investments in flexible computer integrated manufacturing systems. Unnecessary impediments to such investments currently exist. They include the high cost of U,S. capital, bureaucratic procedures, and a number of regulatory statutes all of which present a barrier to such investments. In some cases, the antitrust laws also can be a barrier.

Moreover, the "entrepreneurial independence" of the U.,S. culture often deters collaborative efforts. But shared ownership and operation is necessary since few companies alone can mount the great diversity of skills and disciplines to develop such systems, or carry the full burden of investment risk. That risk must be spread among groups of cooperating companies that are engaged in a multiplicity of diverse markets, but have common types of manufacturing needs (metal machining, plastics extrusion, electronic assembly, for example).

Because both development and plant investment costs can be very great, the lack of availabiltity of low cost risk capital also has become a major impediment. Capital costs in the U.S. are two to three times greater than in Japan, Germany and other nations. Finally, well intentioned regulatory and liability laws unnecessarily impede commercial activities in many areas. Systematic cost/benefit analyses need to be made for each regulation from a global competitiveness point of view, and selective modifications made where necessary.

The State Government Role

During the last five years, many states have been moving from a "smokestack chasing" economic development strategy to one of comprehensive economic development. These new strategies emphasize small business development, applying new technologies to strengthen existing industry, effective training and retraining of the labor force, encouraging transfer of government and university-based research to industry, and making aggressive use of positive tax policy to encourage investment.

These states are emphasizing "investments" in ideas, people, resources, capital development and business development. Many state governors have taken the lead in developing and pursuing such strategies. Some states began this process in the early 1970's, but such strategies were greatly expanded during the inflation/recession of the late 1970's and 1980's. They were further stimulated by the 1981 Economic Recovery Tax Act (ERTA) incentives. The culmination of these forces has produced strong commitments by states to economic development strategies that focus on the present and the future, not the past. New ideas are welcomed by the governors and the continued strengthening of the economy will produce additional state revenues which can be redirected to entrepreneurial activities.

With appropriate preparation, understanding, and the development of an effective partnership program, most states now are positioned to incorporate the concepts of flexible manufacturing, civilian-Department of Defense and federal-state cooperative efforts into their respective strategies. With the exception of a number of specific defense related national security concerns, the flexible manufacturing concept is mutually supportive of the purposes of state economic development diversification programs.

Developing An FCIM Center

Development of an FCIM service center is a staged process, focusing first on component manufacture. Advanced technology can measure an existing part to minute tolerances, program a second machine to produce it, remeasure it for aberrations, and adjust the program to make it correctly. This capability could be of immediate use in some categories of spare parts where engineering drawings or specifications may not be readily available. Automated cutting, machining and forming modules might first be integrated around an inventory of metal and plastic parts required for maintenance of existing systems.

A second stage would begin the integration of newly designed components into a given system through computer-aided design capabilities, followed by systems management of raw materials procurement. Finally, selected component asssembly capabilities might be considered. Parallel tracks of efforts are required involving formation of coalitions of interested groups, inventory of parts to be made, design of a staged development, estimation of costs, and procurement of funding needed.

Enabling Organization

A task force of key representatives has been formed from the Departments of Commerce and Defense, together with the National Aeronautics and Space Administration (NASA) and the Federal Emergency Management Administration (FEMA) to define the initial parameters needed for a number of demonstration facilities. Based on this preliminary definition, the Department of Commerce will encourage industrial and other constituencies to form consortia and initiate detailed planning procedures.

But the primary initiative must come from the local level, particularly groups of U.S. companies. Federal and state governments can only provide the climate for entrepreneurial activity through removal of barriers, provision of incentives, and through the dissemination of information to aid the process. This must be a collaborative not an adversarial process.

Finally, there is no question that it is in the national interest to stimulate developments of this nature. A strongly growing noninflationary economy is essential to the rising quality of life that we all seek. The opportunities for achieving such growth now are unparalleled.

APPENDIX #2

Shared FCIM Project Status*

Advanced Planning Stage

1. Meadville, PA - The National Institute for Flexible Manufacturing being organized by a consortium of small tooling and machining firms and supported by the National Tooling and Machining Association. Business Plan is being developed.

2. West Virginia - A state-wide project coordinated by the State Board of Regents with growing support from several major corporations. Three centers in various areas of the state are in the planning stage.

3. Missouri - A state-wide project planned by a consortium of the private sector and a state organization, and coordinated by the University of Missouri-Rolla. See enclosure #3.

Initial Planning Stage

4. Texas - A project being planned by Texas A&M and the Texas Engineering Experiment Station to include six centers, one in each of the state economic development areas, supported by a "teaching factory" located at the College Station campus.

5. Minnesota - A project supported by The Minnesota Technology Corridor Inc. Incorporation proceedings for the Minnesota Advanced Technology Center as a shared FCIM facility, have begun. The consortium includes the private sector, the University of Minnesota and the State government. Multiple centers are under consideration.

6. Pittsburg, PA - A project developed by the University of Pittsburg with support from the private sector, to be located at the University of Pittsburgh Research Park (UPRPC). UPRPC is the $100,000,000 Gulf research center given to the University when Chevron acquired Gulf.

7. Arkansas - Initiated by the Arkansas Science and Technology Authority, this project is championed by the University of Arkansas in conjunction with the State Industrial Development Authority.

Prepared by the Office of Productivity, Technology and Innovation, March 1988.

8. Philadelphia, PA - Initially being explored by the Delaware County Community College and its Foundation Board which is chaired by a Sun Oil official.

9. Boise, Idaho - A project explored by officials of Boise State University as an integral part of the new College of Technology. There is strong support from the private sector, including Hewlett Packard and interest by the Governor's office.

Consideration Stage

10. New York City - Columbia University is exploring the possible establishment of a shared FCIM facility. The University's new Productivity Center Director is the "champion" for this project.

11. Iowa - Initial discussions have taken place with senior officials of Iowa State University.

12. Illinois - Initial discussions have taken place with the Chicago High Technology Association and the Institute for Illinois. Follow-up is planned in an April or May meeting in Chicago.

13. Utah - A private sector initiative is being considered to establish a shared FCIM facility in the existing machine shop of Geneva Steel which has taken over and reopened the closed USX plant in Provo, Utah.

14. Texas - A second Texas initiative is being explored with the University of Texas, Austin, as part of that state's newly emerging economic development strategy which includes: 1) support for small business development, 2) international trade and 3) 'twin plant' expansion.

15. Oklahoma - The Tulsa Vocational School District is beginning to consider a shared FCIM production facility as an addition to its current state-of-the-art training programs.

16. Florida - A private sector developer, who owns a Research Park in Tallahasse in which are located a super computer center and facilities of Florida State University, is a possible sponsor of a shared FCIM facility as an added component of its Research Park.

17. California - The Washington, D.C.representative of the Office of the Governor of California has reviewed the shared FCIM program and is sending the material to Sacremento for consideration.

18. Missouri - The St. Louis Technology Center had expressed interest in a shared FCIM Facility as an adjunct to its incubation center.

19. Michigan - Northern Michigan University had expressed interest in a shared FCIM facility for the state's northern peninsula.

National Projects

20. The National Tooling and Machining Association which officially endorsed and is supporting the Meadville project plans to explore replication of that project in those areas that have a critical mass of Association member firms which can benefit from shared FCIM.

21. Pryde Roberts and Co., an economic development consulting firm, has expressed a strong interest in the OPTI FCIM program and is actively exploring its implementation with a private sector group in Seattle, Washington and with a second group in California.

22. Officials of Deloitte Haskins and Sells were briefed on the shared FCIM program and have recommended to senior management that the firm consider supporting FCIM centers in appropriate locations.

*As of September 1, 1987 there were only three projects and these were all in the "consideration stage" category. They included Texas A&M, Meadville, and West Virginia.

APPENDIX #3

Examples of Organizations with which OPTI is Working or Discussing FCIM

Arthur Anderson & Co.
National Tooling and Machining Association
Harvard Business School (Ramchandran Jaikumar)
Young Presidents Organization
Automation Forum
Southern Technology Council
United Technologies

Senator LEVIN. How big a program is it?

Dr. MERRIFIELD. It is a limited program. We see ourselves as a catalytic agent of change that basically pulls people together, provides them with information and other sources of information that then can help them do their own thing.

That is what Harold Corner has been doing at Meadville. He has taken that leadership initiative and we have just been helping him with the different processes.

Senator LEVIN. Can you give us an estimate as to how large a budget you would need for planning grants, just talking about planning grants, I gather, for the shared flexible computer-integrated manufacturing facility?

How big a proposal is it? Are you talking about $50 million, $10 million, $100 million? What are you talking about; you are talking about a few million dollars, perhaps?

Dr. MERRIFIELD. Yes.

Senator LEVIN. Is the EDA Program you identified targeted for that or is it a larger EDA Program that hopes to fund this?

Dr. MERRIFIELD. It is in the EDA planning grant category. They may have some generic funds but they have to be limited to disadvantaged areas.

Senator LEVIN. There is no special EDA Program just for this shared flexible manufacturing facility proposal?

Dr. MERRIFIELD. There is not.

Senator LEVIN. They found some funds within a larger program to aid them?

Dr. MERRIFIELD. That's correct.

Senator LEVIN. What would you think about the Small Business Administration—I would like to ask both of you this question—targeting some of their guaranteed loans to applications which involved the utilization of advanced manufacturing processes or perhaps even your shared manufacturing process, what would you think about that, both of you, and probably, Dr. Merrifield, this is primarily directed to you, if there is any merit to that, I don't know if it has been proposed or not by others, could you or have you talked to SBA about that?

Dr. MERRIFIELD. That is a good point. In fact, Dr. Costello and I are working on putting together a task force of not only Government agencies but also working with Bill Norris of Control Data who has been mobilizing the private sector community and State governors.

What we hope to do is put together a consortium of capabilities that will pool resources of this sort. The Small Business Administration, is one that we are hopeful may be interested in being involved in this area.

Mr. COSTELLO. I think pertinent to that is that it is not a Department of Defense issue, or a Department of Commerce issue. It is a broad Government issue, and the more people we get involved with a specific commitment to get something done, rather than to not get something done, I think is significant.

Senator LEVIN. Is that consortium going to be meeting in the next few months?

Dr. MERRIFIELD. Yes, I think—do you remember the date? It is a couple of weeks. I think.

Senator LEVIN. How many meetings does it have?

Dr. MERRIFIELD. This is just starting. This will be really the first organizational meeting, although we have had individual discussions on a number of occasions.

Senator LEVIN. If it is appropriate for our staff to participate or observe even that meeting we would like to offer that and suggest that. I would be very much interested in that process.

Just one more question. Dr. Costello, let me address this to you. I have gone through all of the programs of the Department of Defense that are related in the area we are discussing this morning. I have had difficulty getting them all kind of organized in a way which I can just take, grab and take hold of.

Is there a brochure or one document where the Department of Defense and the Department of Commerce, I would like to ask at the moment the same question, where you identify all of the programs in the Department of Defense which could be helpful to a small business that is seeking to adopt, implement advanced technologies in their processes?

Mr. COSTELLO. I think the programs have changed enough in the last year so that we did have one that would focus on different aspects of it and would perhaps be beneficial for us. We have been meeting with our small business organization and asked, what is our proactive role to get out and really plow the fields and do a better job of involving people, and we will take that up as an issue. If you ask me to put my hand on that brochure, I could not do it myself today either.

Senator LEVIN. Dr. Merrifield, does Commerce have such a brochure?

Dr. MERRIFIELD. What we have been developing are a number of data bases. We have a data base of about 100,000 U.S. companies. We can inventory for specific talents and capabilities that we are looking for for a given, to coalesce in a given situation.

This is one of the things we are using in our impact program, the international program, where we are setting up bi-national cooperative efforts between small- and medium-sized U.S. companies and foreign nation companies to jointly develop new technology and open up access into foreign markets for our small- and medium-sized companies.

We also have a data base of most of the venture capital companies and the sources of R&D limited partnership funding. These are the kinds of support capabilities that we provide.

Mr. COSTELLO. I think that the Senator is looking for something in addition to that. We have the data bases that are well covered and documented in the input that we gave you, but they are difficult to reach.

We have to make it easier and we have to look at the small business community and say what other tools do you need? I am looking for an on-line system so the guy can go to a PC and call up and see immediately what is available. That is down the road.

I think sometime we have to make that data and the information in those substantial data bases readily available. They are available but you have to work at it, Senator.

Senator LEVIN. I asked my staff to give me a list of Federal efforts in this area. What could a small business person, medium-

sized businessperson, do, who could he turn to in the Federal Government, what various programs do we have to be of assistance to him or her if he is trying to introduce advanced technologies into a business which is struggling in order to compete?

We finally got it pulled together. It is a lot of work. It is a lot of work. I am not sure that even though it is all pulled together, my staff has done a good job, that I really understand it. It is not the language that I can understand.

Admittedly I am not a technologically advanced person in this area but still I do think we could use, if we don't already have it, in one place, we are trying to focus on making it possible and providing incentives or help, assistance for people who are willing to invest in advanced technologies to either save a business or to start a new business or whatever, and then I think we ought to put in a very straightforward form the various programs which are available. We may put in there, too, a number of programs we are working on.

This changes from month to month but, perhaps it is hard. At any rate, if there is not that kind of literature available, it would be useful across the Government, not just DOD, not just in Congress.

Dr. MERRIFIELD. Dr. Williams reminds me we do have an inventory for all Government resources in support of small businesses, not specifically focused on flexible Manufacturing, but for all areas. It is available through the National Technical Information Center.

Senator LEVIN. Is that a brochure?

Dr. MERRIFIELD. It is a brochure. It is a thick book actually and it is also on floppy disks.

Senator LEVIN. The gentleman behind you shook his head when I said is it a brochure.

Dr. MERRIFIELD. It is a directory.

Senator LEVIN. Would it be possible to put out a brochure that focuses on this question, how the Government can help you, and people I think will smile at that automatically, but how the Government can help you to install the high-tech, the automated equipment so that your manufacturing plant can compete?

How do we help you with advanced machining, tooling? I just think it would be, hey, look, the DOD has got six different programs, you might want to participate in this. Commerce has programs. SBA has got programs; kind of in one place, but focusing on that issue because that, it seems to me, is the name of the game. Everybody is saying if you want to compete in this world you damn well better use the advanced processes and our manufacturing to do it.

So if we could lump that all together in a brochure it would be helpful.

Mr. Costello, you wanted to add one thing?

Mr. COSTELLO. Also, in the manufacturing technology information analysis centers that the Army has available. We also have 21 area technology centers; but I am sensing from you and I am sensing from my own reaction, what if I am a manufacturer in Iowa, and I have never heard of that. Somebody should make available to me all of the centers that I can go to.

Senator LEVIN. Could you do this, could you get for us, if we don't already have it, from both of your agencies, the brochures that are available that can be broadly disseminated? I am not talking about catalogues, but broadly disseminated brochures that touch this subject?

I will also ask my staff to ask the SBA that. There may be a couple other agencies we are missing. We would like to look at it and see whether or not it puts in one place, in readable form, the kind of assistance that that small manufacturer, medium-size manufacturer that just would like to get a hand on doing this, and it may be that he needs an SBA loan and maybe we ought to urge the SBA to target part of their loans to this, by the way. I don't know.

I would like to know where we ought to go in this area. We have to see where we are. There are all kinds of programs. We have tried to identify them, to put them all together in one place. It is very difficult. I think it is difficult for me. My hunch is it may be difficult also for that small businessperson out there, so if you could get us those documents that would be helpful.

Do either of you have anything else you would like to add at this time?

Mr. COSTELLO. It may be that if sufficient documents or a good document doesn't exist, that Commerce and DOD can get together as part of our pro-active role and see how many small disadvantaged business efforts we have underway.

Senator LEVIN. Or that consortium you just identified, as one of its first actions, could put together a joint brochure. We won't will seek a waiver of the antitrust laws so you folks can work together on it. [Laughter]

Mr. COSTA. We may need a congressional mandate for that to happen.

Senator LEVIN. Whatever you need, you will get it from us. Thank you for coming.

Our last panel this morning is made up of Dr. George Hatsopoulos. He is the founder and president of Thermoelectron Corp., a small manufacturer of advanced technology equipment, chairman of the Federal Reserve Bank of Boston.

Dr. Hatsopoulos has studied and written on capital formation and international competition. Alan Auerbach is chairman of the Department of Economics, University of Pennsylvania, studying and written on the effects of tax policy on business investment. He will correct my comments on the new tax bill.

William Norris is chairman emeritus of Control Data Corp., whose company has been involved in advanced manufacturing technology and Mr. Norris has examined barriers to small business use of advanced technology and has proposed a solution similar to the shared flexible manufacturing proposal that Mr. Corner and Dr. Merrifield have testified on which could, indeed, involve some Federal role.

So, Dr. Hatsopoulos, Dr. Auerbach, Mr. Norris, are you a doctor, by any chance?

Mr. NORRIS. No, a plain mister.

Senator LEVIN. Mr. Norris, we welcome all of you and thank you for the time you have taken to help this Subcommittee figure out

what additional Federal role or reduced Federal role perhaps in some areas we ought to look at in order to provide incentives for the advanced technologies to be utilized by these small- and medium-sized manufacturers. Why don't we call on you first, Dr. Hatsopoulos.

STATEMENT OF DR. GEORGE N. HATSOPOULOS, CHAIRMAN OF THE BOARD, FEDERAL RESERVE BANK OF BOSTON, AND CHAIRMAN OF THE BOARD, CEO, THERMO ELECTRON CORP., WALTHAM, MA

Dr. HATSOPOULOS. I believe these hearings address a problem critical to the future of this Nation, and, therefore, I am very pleased and flattered that you invited me to testify here.

I wish to preface my remarks, however, by pointing out that I will not be speaking as a member of the board of the Federal Reserve Bank of Boston and, for that matter, not even as a CEO of a mid-sized technology-oriented company that has grown quite rapidly.

Rather, I would like to address this subcommittee and speak as a student of the competitiveness problem facing America, a problem that can lead to a major decline of our relative position in the world.

The problem is much more serious than what people have come to believe. Several of the studies with my colleague and my collaborators from MIT and Harvard have indicated that we have been losing to our major competitor, Japan, at a rate of about 7 percent a year for the last 15 years.

This means that 10 years ago the Japanese workers in manufacturing were getting paid about half as much as our workers. Now they are getting paid the same. And if that trend continues for the next 10 years our workers will be getting paid about half as much as the Japanese workers in manufacturing.

You asked me to address the question of capital financing for corporations, especially mid-sized and small companies. I have studied this problem with several of my collaborators for the last several years.

We have found that corporations in America, both large and small, have great difficulties in obtaining adequate capital financing. The reason is that the cost of capital is prohibitively high.

I would like to point out that in our studies we have found that the cost of capital to American corporations is about 200 percent higher than it is in Japan. This large disparity is related both to America's low rate of national savings and to its tax policies.

We might, of course, debate whether our low national savings rate is the result of our tax policies or whether our tax policies are necessitated by our low rates of national savings.

Whatever it is, there is no question that the cost of capital for American business, and the savings rates in America are very closely related.

Now, America's competitiveness problem is exacerbated by the fact that small- and mid-sized companies, which have provided the major growth in this country in the last half a dozen years, are even more disadvantaged than large multi-national corporations

because the smaller, fast-growing technology companies are involved with new ventures which pose high risk.

Also, these corporations are mostly based in this country, whereas larger corporations can take advantages of favorable terms of capital finance available in other parts of the world.

The reason fast-growth, smaller companies are more disadvantaged than the others, the large ones, is because debt financing for large corporations is much easier than for small ones. In fact, smaller corporations depend mostly upon equity financing for their capital.

We have found that the real cost, after-tax cost of equity to American firms is about four times as large as the real after-tax cost of debt. The reason is that interest payments are tax-deductible, whereas payments to equity holders are not.

In Japan, by contrast, both the real cost of equity and the real cost of debt are low, and about the same for either equity or debt.

Now, it might be interesting to see how that comes about. First of all, let me point out that the low cost of equity in Japan is reflected in the high price-to-earning ratios of their corporations, a factor which many people have written about.

In part, the differential is so large between here and Japan because the appreciation of corporate equities at the personal level are not taxed at all in Japan. On the other hand, taxes on any other income in Japan on the personal level are taxed at high rates, in some cases as high as 70 percent.

The stated rationale of Japanese tax policy, which I have read in their Tax Code, is that corporate equities are already taxed at the corporate level; whereas, all other payments made by corporations to individuals are tax-deductible at the corporate level—payments such as interest payments or other such payments made by corporations.

This, in effect, is a way to eliminate the double taxation on equity, and to equate in a more neutral way the cost of debt to the cost of equity.

Now, congressional attention has recently focused on proposals to reduce capital gains tax rates. We believe that a better strategy would have the reductions targeted to corporate equities, which, by the way, account for only about 30 percent of capital gains tax revenues.

This specifically targets where the problem is. We believe that a skillfully designed tax exclusion, targeted to equities of all corporations in general, and those of smaller companies in particular, could reduce the United States cost of capital substantially.

Now, there are many ways that the cost of capital in the United States can be made more competitive to that of our major competitors, and a lot of that has been talked about and proposed. There are many good ideas. Some of them involved a lot of cost to the Government, and some involved less cost.

Many have different effectiveness and different costs associated with them. What is regrettable is that in spite of all of this discussion and knowledge in the private sector and among economists and businessmen, the Government, for the last few years, has paid little attention to this issue of capital formation or the cost of capital.

In particular, the Tax Reform Act of 1986 never mentioned a debate or discussion of whether one action on the part of the Tax Code would increase or decrease the cost of capital, or how that increase and decrease might affect the revenues so that an optimum strategy could be taken that gives the biggest bang for the buck.

I just want to cite one example. There was a discussion, as you know, Senator, about whether we should eliminate the ITC. Those discussions that were going on in 1984, 1985, 1986 considered whether we need the revenues and whether we should put them somewhere else.

There was never brought into the discussion the fact that you could have all of the benefits of the investment tax credit at a third of the cost by making the tax credit on an incremental basis. In other words, give the tax credit only to investments that are above the depreciation, above the existing capital.

I am not suggesting that this is the optimum way. All I am suggesting is that the debate never addressed the question of capital formation, productivity or the competitiveness of the United States and, with that, I would like to close by saying that this is a very important problem facing the Nation, and we had better address it in the next 2 or 3 years. Otherwise, by the year 2000 we will end up being where England is, relative to other industrialized nations.

[The prepared statement of Dr. Hatsopoulos follows:]

Testimony

George N. Hatsopoulos

Senate Small Business Committee

Subcommittee on Innovation, Technology, and Productivity

March 1, 1988

Mr. Chairman:

I believe that these hearings address a problem critical to the future of our Nation, and I, therefore, am pleased that you have invited me to testify. I wish to preface my remarks by pointing out that I will be speaking not as a member of the Federal Reserve Board of Directors, nor as CEO of a fast growing, mid-sized, technology company. Rather, I will be speaking as a student of the competitiveness problems facing America -- problems that could lead to a major decline in our relative world position. The problem is so serious that, at present rates, American workers are losing ground to the Japanese counterparts at 7 percent per year.

Corporations in America, both large and small, have difficulty in obtaining adequate capital financing -- capital is available, but at prohibitive cost. Our cost of capital is, in fact, about 200 percent higher than that of Japan. It is clear that this large disparity is related both to America's low rate of national savings and to its tax policies. We might, of course, debate whether our low national savings rate is the result of U.S. tax policy or whether the tax policy is caused by low national savings.

America's competitiveness problem is exacerbated by the fact that small and mid-sized technology companies are burdened with a higher cost of capital than large multinational corporations because new ventures involve greater risk. Thus, they have less access to debt financing than large corporations and must rely more upon equity financing. The real after-tax cost of equity to

American firms is about four times larger than the real after-tax cost of debt, because our interest payments are tax deductible, whereas dividend payments to equity holders are not deductible. In Japan by contrast, the real after-tax cost of equity is about as low as that of debt.

The low cost of equity in Japan is reflected in the high price-to-earning ratios of their corporations. In part, this results from the large differential between taxes on the appreciation of corporate equities not taxed at all in Japan, and taxes on other income which can incur rates of up to 70 percent. The stated rationale of Japan's tax policy is that corporate equities are already taxed at the corporate level, whereas all other payments to individuals are tax deductible at the corporate level. Congressional attention has recently been focused on proposals to reduce capital gains tax rates. A better strategy would involve reductions targeted to corporate equity, which accounts for only about 30 percent of capital gains tax revenues.

A skillfully designed tax exclusion -- targeted to equities of all corporations in general, and to those of smaller companies in particular -- could reduce U.S. cost of capital substantially. An alternative approach would be to provide an incremental investment tax credit applicable to investments in excess of depreciation. Although the precise definition of net investment depends upon assumptions about the actual rate at which capital decays, and this requires careful legislative drafting, the underlying principle is clear. Applying the credit only to net investment preserves the same incentives as the existing ITC for any firm with a growing capital stock. At the same time, such a measure reduces the Federal revenue cost of

the investment credit by about 70 percent (the ratio of net to gross business equipment investment was .31 in 1986). Even if the incremental ITC were financed by an increase in corporate tax rates, it would provide a much needed reduction in the cost of capital at the margin, and this is the critical factor affecting investment decisions.

Senator LEVIN. Dr. Hatsopoulos, thank you very much. Our plan now is to call on the other members of this panel.

But first let me welcome Senator Boren, a dear friend, and I know a dear friend of a number of members of this panel. He is also on the Finance Committee. So I am completely delighted that he is at my side today because we will spend a little bit of time on the tax policy in a few minutes with you.

STATEMENT OF HON. DAVID L. BOREN, A U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator BOREN. I do have high regard for the members of this panel. Dr. Hatsopoulos has been one of my tutors in the field of the cost of capital for a long, long time and I have learned a great deal from him and I am sorry that I was in another meeting and I attempted to get here before he made his remarks, but I look forward to hearing from the entire panel and hearing the discussion that follows and appreciate the opportunity to be here.

Senator LEVIN. Senator Boren is not only our expert on some of your teaching on the cost of capital but is also the expert on how to drive the cost of elections down. He hasn't quite yet succeeded but he is still trying.

Dr. Auerbach, let me call on you next.

STATEMENT OF DR. ALAN J. AUERBACH, CHAIRMAN, DEPARTMENT OF ECONOMICS, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA

Dr. AUERBACH. I appreciate the opportunity to come here and testify on the effects of Federal tax policy on the ability particularly of smaller manufacturing companies to innovate and finance their capital needs.

I have a full statement I would like put in the record. I would just give you a few selected comments to give you a flavor of what I say in the statement.

First, I should mention what my conclusions are. They are really very straightforward and not very exciting, although somewhat disappointing if one is looking for new solutions rather than old ones.

First, the continual enactment of new business tax provisions reinforces the uncertainty under which business must operate. Dealing with this uncertainty appears to be more difficult for smaller companies than large ones.

I think there was some discussion of the difficulties among small businesses in obtaining information earlier in the hearing. Prospective tax reforms should be evaluated, therefore, as permanent solutions and not temporary measures.

Second, any plan to help small business using the Tax Code must recognize the risky nature of small enterprises and the fact that many such businesses pay little or no Federal taxes in particular years, and third, the most important impact of fiscal policy on capital intensive manufacturing companies, large and small, is the Federal budget deficit which has driven and continues to drive the path of real interest rates and the cost of capital and trade deficits.

International competitiveness is influenced, I believe, by the level more than by the structure of taxation in this case. In my tes-

timony I go through some of the key provisions currently in the Tax Code and then I talk about potential changes and also some of the difficulties confronting you as you consider tax reform to help such companies.

First of all, and most obvious, I suppose, are investment incentives. Of course until recently capital intensive business received two major incentives to purchase their capital equipment, the investment tax credit and accelerated depreciation. Provisions of this encourage incurs capital investment in two ways: First they lower the tax burden on prospective investments, giving such projects a higher and more attractive return. Second, and I think of particular importance for smaller businesses, these incentives also supply some of the funds necessary to finance these investments.

I emphasize the second element of investment incentives when thinking of small business because there is some evidence, and I think Dr. Hatsopoulos touched on this, that smaller enterprises have poorer access to capital markets than larger, more established companies and must rely more on internal funds to finance expansion. In a sense, by giving tax breaks like the investment tax credit that coincide with investment rather than simply by lowering taxes on subsequent income, the Government is acting as a banker for small business.

Now, there is room for debate and there obviously has been ample debate about whether it was appropriate to reduce investment incentives in the 1986 Act, but I think certainly for small, fast-growing capital-intensive companies the reduction in tax incentives has had an adverse impact.

Now, a second potentially important incentive for companies of which I speak is the research and experimentation credit which was reduced but not eliminated in the 1986 act.

Despite its billing as a large tax credit, first 25 and then 20 percent, the RE credit has a very low average effective rate, probably about 2 percent it has been estimated. This is because the RE credit is a net credit of the kind that Dr. Hatsopoulos mentioned that depends on prior years' research and experimentation expenditures to determine a base over which the credit is received.

Indeed, by spending more on research and experimentation today you reduce the credit that you will receive in the future and because of the byzantine mechanism that determines the credit in given years, it is actually possible for a company undertaking research and experimentation expenditures which qualify for the credit actually to lose money because of the credit. They actually may have an increase in their taxes. Certainly that should give one pause in thinking about credits of that sort on other types of activity.

Now, another important type of tax which affects businesses of this sort is the capital gains tax. Obviously, even if it doesn't affect the businesses themselves, it affects the ability of them to obtain capital.

Therefore, for small companies with limited access not only to credit markets but also perhaps to internal funds, particularly new companies, this is an especially important issue.

From a revenue standpoint, an increase in capital gains tax may very well raise little new revenue, and this has been discussed at

some length, I think, in the last few years because the timing of realization of capital gains depends on the tax rate.

At the same time, I think, one should realize that simply cutting capital gains taxes is not a particularly effective way of encouraging capital investment, or the growth of the small enterprises.

Certainly focusing the capital gains cut on marketable securities rather than on things like housing would be a step in the right direction if one were thinking of a capital gains cut, but even if one is thinking of the marketable securities, only a tiny fraction of all capital gains realized are associated with small, fast-growing capital-intensive, venture capital enterprises that I think we are talking about here.

As one thinks about the types of tax changes that might be appropriate to deal with some of the problems that small business faces, there are two problems I would like to highlight.

One is the problem of tax constraints and its relation to risk-taking. This is one that is very difficult to discuss. It is a very controversial subject and I believe is one of the most poorly understood problems of tax policy.

There is a common perception that firms that don't pay very much in taxes in a particular year are either fiddling with the Tax Code or in some other way not paying their fair share.

I think the mark of such perceptions are very strong in the Tax Reform Act of 1986, the increased minimum corporate tax, the reduction in the ability to transfer tax benefits through mergers, and so forth.

I don't wish to suggest that such views are entirely without merit in particular cases. But, as a broad description of the firms involved, they are quite misleading. I believe an adherence to them makes the achievement of certain tax policy goals more difficult.

The facts in this case are really much less mysterious than one might infer from the debate. Indeed, the major reason why some firms pay little or no tax is that they have little or no income, which probably wouldn't come as a surprise to someone who didn't know much about corporate tax, but seems to become more of a surprise to people who talk about it a lot.

A second important reason is that firms are sometimes unable to use all of the tax benefits due them under the major provisions of the law. Indeed, my own research estimates that during the recession year of 1982, which is not necessarily typical of the more recent period, more than half of the assets of the United States corporate sector were held by firms that paid either no taxes at all, which is about a fifth of the corporate sector, or paid taxes but were not able to use all of the investment tax credits to which they were entitled, which is about another third of the corporate sector, nonfinancial corporate sector.

And my research also suggested it was really the macroeconomic conditions of the time rather than the changes in tax policy of the early 1980s that led to this incidence of tax losses and inability to use credits.

And of importance to the current discussion is the fact that the incidence of these tax constraints is quite strongly related to a business's size. Smaller companies are less likely to pay taxes.

Once again it is important to stress why there is a problem. Firms that pay no taxes or are losing money are accumulating capital and unable to use the investment incentives that they are receiving already, and among these firms are the firms that need the tax benefits the most, which are firms that are relying on internal funds.

So, attempts to make investment incentives more attractive for companies like this won't meet with much success unless the incentives are made accessible to such companies through some mechanism in the Tax Code. But one only has to look at the short and unhappy life of Safe Harbor Leasing in 1981 to know how difficult it is to come up with a tractable and politically acceptable solution to that.

Now, the problem of tax constraints is present at the private investors' level, too. Here again, this is one of the problems associated with the capital gains tax.

If you think of a supplier of equity funds to a new risky enterprise, and the investor that we are thinking of is one we would like to encourage, this investor faces an unfortunate situation. If he succeeds, there will be capital gains and capital gains taxes, too. If he fails, there will be corresponding capital losses.

These losses, however, are deductible only to a very, very limited extent from other income and, hence, the investor is subjected to a game against the Government of heads I win, tails you lose.

And once again, therefore, the constraints on tax deductions typically affect small, newly-capitalized ventures that depend on venture capital, seeking capital gains. Getting capital gains taxes, as I said, would make all investments more attractive, including these, but I don't think that would be a particularly effective way to go.

The real problem, if one is thinking of targeting risky ventures, lies in the limited deductibility of potential capital losses that come from such ventures.

Indeed you don't have to think of an investor as expecting to incur losses on a given project. If there are a lot of projects undertaken and they are very risky, a realistic evaluation of the investment prospects would certainly predict that some of them would incur losses.

A solution in terms of providing greater incentives here lies in a move to a system under which it would be possible for investors to deduct a greater fraction of their capital losses immediately.

The only way to do so without simply observing lots of capital losses being realized and no capital gains would be to move to a system of providing less flexibility for capital gains as well, not necessarily for all assets because that might be unworkable but perhaps for limited types of financial assets.

It might be possible, as we do already for certain financial instruments, to mark these assets to market annually and tax not only the gains but also allow deductions for the full amount of the losses on these investments. One could think, for example, of providing this for certain classes of equity investors.

The second problem that confronts potential tax change is the frequency of tax reform itself. You know, having been involved in the process, how frequently the tax law has changed in recent

years and indeed it has changed more frequently in recent years than it had in earlier decades.

As a student of tax policy I find this very stimulating but as a taxpayer I don't, and I don't imagine others do either.

Previous studies by the Government have found that smaller businesses react more slowly to tax changes than larger companies even when it is to their advantage to do so. That isn't particularly surprising.

Beyond the difficulty of complying with the frequency of these complex tax changes, the changes, having frequency, are costly in other respects as well because taxpayers who believe that they will be subject to changes may find it advantageous to behave in ways not desirable from the social viewpoint.

I have two cases in mind. The Tax Reform Act of 1986 got rid of the investment tax credit permanently; so did the Tax Reform Act of 1969. Here we are in 1988 considering new investment incentives.

It doesn't take a very sophisticated person to infer that the permanent removal of the ITC may be very short-lived. What type of behavior will this induce? Well, it will discourage investment as businesses delay those projects that have something to do with flexibility.

Similarly, continually raising and lowering the tax rate on capital gains encourages investors to wait for a low tax year to realize their gains, not something that we necessarily want to happen. Beyond these expectations—induced changes in behavior, the possibility of tax law changes creates an uncertain environment which I would guess again has a stronger impact on small business that makes these individuals worse off. It makes planning more difficult and each change in the tax law contributes to a reputation that the Government has established in recent years for changing the law frequently.

As I come to the conclusion of my comments, I say in my testimony that I wish to avoid presenting you with Hamlet without the prince, so I better say the word "deficit."

The most serious problem facing capital-intensive American industry is, at the moment, the enormous merchandise trade deficit. Almost all of it is accounted for by the manufacturing sector which means that our domestic production is geared toward production in other industries while we purchase substantial quantities of manufactured goods abroad.

The fall of the dollar has helped, finally, and indeed if the trade balance is to be closed further, most of the gain will have to come in manufacturing. If one looks at trade statistics there is really nowhere else for us to get substantial increases in exports and declines in imports than in the manufacturing sector. It is the only trade-sensitive sector that is large enough.

The recovery in trade and in the manufacturing sector may be slow and it may require a dollar substantially lower even than it is now as long as the United States maintains its currently low national savings rate and strong demand for foreign goods.

With the low national savings rate we must either sacrifice profitable domestic investment projects or obtain foreign funds to finance them. Following the latter path, as we have in the 1980's,

requires that we run an offsetting trade deficit. Without increasing national savings, which is now running about 2 percent of GNP, we will watch domestic investment decline as the trade deficit improves. It has to happen.

Now, increasing national savings would help reduce the trade deficit without requiring a weak dollar or decline in investment. There are two sectors that increased savings can come from, the public sector and private sector.

Increasing private savings even marginally has proven very difficult over the years. You have had changes in the tax treatment of savings and the private savings rate has been relatively stable; in fact it has declined in recent years.

The most proven way of increasing national savings is the same route taken to decrease them in the 1980's, which is through public savings, the Federal budget, which brings me to the last point I made at the outset of my comments.

The most important fiscal actions that you can take to improve the competitiveness of small capital-intensive business is to enact policies of reduced deficits. How such deficit reduction is achieved matters less as long as it is real deficit reduction and not, for example, raising money by selling Government assets.

If deficit reduction is not addressed, I think other tax policies to help small manufacturing companies are likely to be relatively unimportant by comparison. In conjunction with the deficit reduction plan, certain very specific changes in business and capital income taxation designed to increase the penetration of investment tax incentives to small companies, and to improve the capital gains tax treatment of risky investments would help and would have relatively minor revenue effects, but I do not see a role for yet another round of major business tax changes in this policy package.

[The prepared statement of Dr. Auerback follows:]

TAX POLICY AND SMALL BUSINESS

Testimony before the Committee on Small Business, Subcommittee on Innovation, Technology, and Productivity, U.S. Senate

by Alan J. Auerbach

Professor of Economics and Chairman, Department of Economics
University of Pennsylvania
Research Associate, National Bureau of Economic Research

March 1, 1988

Mr. Chairman and Members of the Subcommittee:

I appreciate the opportunity to testify before this subcommittee on the effects of federal tax policy on the ability of small manufacturing companies to innovate and to finance their capital needs. Much of what I have to say does not apply exclusively to small business, for there are many important effects of tax policy that do not discriminate by a company's size. In my comments, I will first review the tax provisions that are particularly important for the financing of small businesses and how changes in these provisions in recent years have altered the terms on which such businesses operate. This will lead me into a discussion of what can and should be done, given the current fiscal environment. The conclusions I draw are simple enough to state at the outset:

1) Continual enactment of new business tax provisions reinforces the uncertainty under which business must operate. Dealing with this uncertainty must surely be even more difficult for smaller companies than for larger ones. Prospective tax reforms should be evaluated as permanent solutions and not as annual measures.

2) Any plan to help small business must recognize the risky nature of small enterprises and the fact that many such businesses pay little or no federal taxes.

3) The most important impact of fiscal policy on capital intensive manufacturing companies (small and large) is the federal budget deficit. This has driven and continues to drive the path of real interest rates and trade deficits. International competitiveness is influenced by the level more than the structure of taxation.

The Current Tax Environment

There are a number of key federal tax provisions affecting the growth and competitiveness of small businesses. Some of these affect businesses directly and others do so indirectly through their impact on the willingness of investors to supply capital to such businesses.

Investment Incentives

Until recently, capital intensive business received two major incentives to purchase new capital equipment: the investment tax credit and accelerated depreciation. The generosity of these incentives reached a peak in 1981. The investment tax credit was repealed in 1986.

Provisions of this sort encourage capital investment in two ways. First, they lower the tax burden on prospective projects, giving such projects a higher and hence more attractive return to investors after taxes. Second, and of particular importance for smaller businesses, these incentives also supply some of the funds necessary to finance these investments. For example, the ten percent investment tax credit that

applied until 1986 not only gave business a lower tax burden but did so when it was most needed, when funds were required for investment.

I emphasize this second element of investment incentives when thinking of small business because there is some evidence that smaller enterprises have poorer access to capital markets than larger, more established companies and must rely more on internal funds to finance expansion. In a sense, by giving tax breaks that coincide with investment rather than simply reducing taxes on the subsequent income from such investment, the government is acting as a banker for small business: it gives the investor the tax refund in advance, and then is "repaid" by collecting full taxes on the income from the investment.

There is room for debate, and indeed there has been ample debate, about whether it was appropriate to reduce investment incentives in the Tax Reform Act of 1986. Doing so reduced the disparity in tax treatment of different assets and hence corrected the distorted allocation of capital in the United States. At the same time, however, the overall tax burden on capital rose, especially the burden on the new investment toward which the investment incentives were targeted. My own estimates suggest that the net impact on overall economic welfare was relatively small, with advantages and disadvantages of roughly the same magnitude. However, for small, fast growing capital intensive companies, the reduction in tax incentives has certainly had an adverse impact.

The Research and Experimentation Credit

An important tax provision for small, rapidly growing high technology

businesses is the Research and Experimentation Credit. The R&E credit was introduced in 1981 and reduced from 25 percent to 20 percent in 1986. Despite its billing as a large tax credit, the R&E credit has a very low average effective rate, around 2 percent. This is because R&E expenditures from the current year reduce the future credits that the firm can receive, by raising the "base" over which future R&E expenditures must go to qualify for the credit. Hence, the credit's incentive effect is not as large as might be supposed. Indeed, there are many firms for which the credit has the perverse effect of actually discouraging R&E expenditures.

Capital Gains Taxes

Even though capital gains taxes on the shares of public corporations are paid by shareholders and not the companies themselves, it makes sense that higher taxes on shareholders will make them less eager to supply funds to corporations. For small companies that have limited access to credit markets or internal funds, this is an especially important issue.

The 1986 changes, once again, wrought some good and and some bad. Taxing capital gains at the same rate as ordinary income represents an important simplification of the tax code, but failing to allow investors indexation of their capital gains for inflation while raising the rate of capital gains taxation has led to an increase in the tax burden on capital gains and hence an increase in the "lock in" effect, which prevents investors from realizing their capital gains by selling their appreciated assets. From a revenue standpoint, this may mean that increasing capital gains taxes raises little revenue.

While increasing capital gains taxes may be economically harmful, one should also realize that simply cutting them is not a particularly effective way of encouraging venture capital investment and the growth of small enterprises. A tiny fraction of all capital gains in the U.S. are associated with such investments. A recent Treasury study put the fraction of nonfinancial corporate equity represented by venture capital at about 1 percent of the total.

Special Problems Confronting Tax Reform

I have tried to indicate the most important provisons of the tax structure facing small capital intensive companies, and how they affect the ability of such companies to grow and compete. Before one considers changing such provisions, however, there are some important problems to consider that hamper the government's ability to provide additional incentives for investment by these enterprises. Two that I wish to highlight because of their importance are the inability of many firms and investors to benefit from additional tax incentives and the expectations brought about by frequent tax reforms.

Tax Contraints and Risk Taking

One of the most poorly understood problems of tax policy is that associated with firms that pay little or no taxes. There is a common perception that such firms are fiddling the tax code or simply "not paying their fair share", and the mark of such perceptions on the Tax Reform Act of 1986 is clear: the strengthened corporate minimum tax and the reduced ability to transfer unused tax benefits through mergers indicate an

aversion to firms with low tax bills. While I do not wish to suggest that such views are entirely without merit, they are quite misleading; adherence to them makes the achievement of certain tax policy goals very difficult.

The facts are really much less mysterious than one might infer from the debate. Perhaps the major reason why some firms pay little or no tax is that they have little or no income. A second important reason is that firms are unable to use all the tax benefits due them under the law. My own research estimates that during the recession of 1982, over half the assets of the U.S. corporate sector were held by firms which either paid no taxes at all (about one-fifth of all firms, weighted by assets) or paid taxes but did not use all the investment tax credits to which they were entitled (about one-third of all firms, weighted by assets). This research also suggests that it was the macroeconomic conditions of the time (a low rate of profit and high real interest rates) rather than the generous tax policy that made the problem so serious in the 1980s. Of importance for the current discussion is the fact that the incidence of such tax constraints is quite strongly related to a business's size: smaller companies are less likely to pay taxes.

Once again, it is important to stress why this is a problem: firms that pay no taxes are firms losing money or accumulating capital too rapidly to use the investment incentives which come with the newly purchased assets. Among these firms are many of those that need the tax benefits the most, the small firms that require internal funds to grow. Yet attempts to make investment incentives accessable to such companies in the past have been extremely unpopular. The short and unhappy life of "Safe Harbor Leasing," introduced in 1981 and repealed the following year,

is an object lesson. There are alternative approaches to solving this problem, but it is hard to know if they would be any more popular.

Without further changes in the structure of taxation, therefore, investment incentives do not reach a substantial part of the corporate sector. Indeed, the strengthened corporate minimum tax has increased the number of firms that cannot make full use of additional investment incentives: there are now firms that have sufficient taxable income to use all their tax deductions but must "give some back" as a result of the alternative minimum tax computation. Providing these firms with more accelerated depreciation allowances, for example, would not reduce their tax payments unless such allowances could also be deducted from the minimum tax base. A similar argument applies to prospective changes in the R&E credit.

The problem of tax constraints is present at the private investor's level, too. Consider the supplier of equity funds to a new, risky enterprise. If the undertaking succeeds, there will be capital gains and capital gains taxes, too. If it fails, there will be corresponding capital losses. These losses, however, are deductible only to a very limited extent from other income. Hence, the investor is subjected to a game of "heads I win, tails you lose." This same problem is much less severe for investors in diversified portfolios of large companies, since the probability of substantial losses is so much lower. Once again, therefore, the constraints on tax deductions particularly affect small, newly capitalized ventures.

Cutting capital gains taxes would certainly make investments in such ventures more attractive. As I already indicated, however, most of the

benefits of this tax cut would go elsewhere. The real problem lies in the limited deductability of capital losses from risky ventures. The solution lies in a move toward a system under which it would be possible for investors to deduct a greater fraction of their capital losses immediately, but such a move would be possible only if investors were provided less flexibility with respect to the realization of capital gains. Otherwise, losses would be realized but gains would not. A system of marking a limited class of financial assets to market annually, and taxing the measured capital gains and losses at a relatively low rate, is feasbile and would have a minor revenue impact.

Frequent Tax Changes

As a student of tax policy, I find it stimulating to have so many changes in federal taxation over such a short period of time, but as an ordinary taxpayer I would not, especially if I were a taxpayer trying to time my investments in durable capital to occur during a brief period of government munificence. Virtually every year since 1981 has witnessed some changes in the taxation of business capital; the changes in 1981, 1982 and 1986 were quite significant by historical standards. Previous studies have found that smaller businesses react more slowly to tax changes than larger companies, even when it is to their advantage to do so. For example, a survey in the 1970s conducted by the Treasury's Office of Industrial Economics found that a much greater fraction of large than small companies had adopted the favorable Asset Depreciation Range System first introduced in 1971. This suggests that small businesses may not be as successful as

their larger counterparts at sensing and reacting to changes in the tax environment.

Beyond the difficulty of complying with frequent and complex tax changes, these changes are costly in other respects as well. Taxpayers who have reason to believe the tax law will be subject to important changes in the near future may find it advantageous to behave in a way not desirable from a social viewpoint. Two cases in point are the frequent changes in investment incentives and in capital gains tax rates. The Tax Reform Act of 1986 got rid of the investment tax credit permanently. So did the Tax Reform Act of 1969. Here we are in early 1988, considering new investment incentives. It does not take very sophisticated reasoning to infer that the "permanent" removal of the ITC may be very short-lived. What type of behavior will this induce? It will discourage investment, as businesses delay those projects that have sufficient flexibility.

Similarly, continual raising and lowering of the the tax rate on capital gains simply encourages investors to wait for a low tax rate year to realize their gains. Empirical evidence suggests that the rate of capital gains realization depends at least as much on <u>variations</u> in an individual's capital gains tax rate from year to year as the overall average tax bracket of that individual. Not only is this bad from a revenue standpoint, since realized gains are being shifted into low tax years, but it also makes capital gains tax rate cuts appear more effective than they really are at bringing forth greater realizations. Put simply, a permanent cut in capital gains tax rates will have a considerably smaller effect on realizations than a similar size rate cut perceived to be quite short-lived.

Beyond these expectations-induced changes in behavior, the possibility of tax law changes creates an uncertain environment that makes risk-averse individuals worse off. Each change in the tax law contributes to a reputation that the government has established over the years.

The Importance of Fiscal Balance

I wish to avoid giving you Hamlet with no Prince, so let me say the word: deficit. The most serious problem facing capital-intensive American industry at the moment is the enormous merchandise trade deficit, almost all of which is accounted for by the manufacturing sector. This means that our domestic production is skewed toward production in other industries, while we purchase substanital quantities of manufactured good from foreign producers. The fall in the dollar has finally appeared to help reduce this deficit, according to recent trade figures. Indeed, if the trade balance is to be closed further, the gains will have to come in manufacturing, for this is the only trade sector of sufficient size and capacity for substantial gains in exports and reductions in imports. Thus, manufacturing will eventually recover even without intervention. But the recovery may be slow, and may require a substantially lower dollar to occur, as long as the U.S. maintains it currently low national savings rate and strong demand for foreign goods.

With a low national savings rate, we must either sacrifice profitable domestic investment projects or obtain foreign funds to finance them. Following the latter path, as we have during the 1980s, <u>requires</u> that we run an offsetting trade deficit. This is a basic identity of national income accounting, not a refutable proposition of economic theory. Without

increasing national saving, we will watch domestic investment decline as the trade deficit improves. Increasing national saving now would thus help reduce the trade deficit without requiring such a weak dollar and a subsequent decline in investment. The most proven way of increasing national saving is the same route taken to decrease it in the 1980s: the federal budget. Dissaving at a rate of nearly 5 percent of GNP for the past several years, the federal government has offset most of the saving done by the private sector. We know how to bring this percentage down. Increasing private saving even marginally, on the other hand, has proved difficult in the past.

This brings me to the last point made in my introductory comments. The most important fiscal actions you can take to improve the competitiveness of small capital intensive business is to enact policies that reduce the budget deficit. How such deficit reduction is achieved matters less, as long as it is real deficit reduction and not, for example, raising money by selling government assets.

If tax policy is chosen to reduce the deficit, there are basically four approaches to take: broaden the income tax base, raise income tax rates, introduce a new tax, such as the Value Added Tax, or increase revenue from an assortment of individual tariffs and excise taxes. General rate increases are the easiest way to get large sums of money but probably also the least advisable, given the strong commitment to low rates made in 1986 and their economic advantages as well. Likewise, adding the machinery of an entirely new tax will not be very cost effective unless we are committed to raising a substantial part of our revenue from it in the future. My sense is that the experience that other countries have had with the VAT

supports the Treasury's 1984 rejection of it as an alternative for this country. This leaves base broadening and selective tax increases, each of which can contribute to significant deficit reduction.

If deficit reduction is not addressed, other tax policies to help small manufacturing companies are unlikely to be very effective. In conjunction with a deficit reduction plan, certain very specific changes in business and capital income taxation designed to increase the penetration of investment tax incentives to small companies and to improve the capital gains tax treatment of risky investments would help and would have relatively minor revenue effects. I do not see a role for yet another round of major business tax changes in this policy package.

Senator LEVIN. Thank you.

Before we call on you, Mr. Norris, I want to call on my colleague, Senator Boren, because he must leave and has a few questions.

Senator BOREN. Let me ask a question of each member of the panel maybe for just a brief response.

It appears to me you talked about the deficit. It appears to me that next year we are really going to be in a sort of water shed period in terms of future tax policy because this year it is not very likely we will have major changes.

Unless the budget figures are really off, there appears to be an inclination on the part of everyone to accept the rather optimistic OMB figures so that the budget agreement of last year will not have to be reworked this year, in election years.

So we will have gone through every amount of creative budgeting that we can possibility go through with smoke and mirrors and every other device to try to bring the deficit down, and next year we are going to begin to face the real crunch.

We will continue to make progress and we must make progress in this area. So we will be facing a package sooner or later that will include tough spending cuts in such areas as defense and entitlements. We will have to face up to where the remaining spending still is that hasn't been hit very hard to this day. And we will look at revenues obviously as a part of a package.

That is looming in 1989–1990, and I guess the main question is what will be the thrust of where these revenues will come from, sort of three options that have been put on the table.

One would be from the income tax side, again, which would in essence hint of capital formation. The other would be essentially consumption based sorts of taxes, perhaps export rebateable to try to keep a competitive edge, and the third would be sort of a variation of the second, which is specialized areas of excise taxation and, I guess the one that has gotten the most attention because of maybe the part of the country where I reside, I pay special attention to it, is in the area of energy taxation. It has been felt that our real energy costs are below what they should be, that the costs are below their real costs, certainly replacement costs, and that you might see some sort of a combination, a floor price which would have the effect of a variable import fee, coupled with some sort of fuel tax, like a gasoline tax, and since the Northeast uses less gasoline per capita than the West, and since the west uses far less home heating oil in the kinds of things that come from imports than it does in the Northeast, that it would have some sort of a balance in the sense that both areas of the country would be sacrificing, some sort of composite that we put together.

I wonder how the three of you would respond to this situation from the point of view of capital formation, from the point of view of smaller business enterprises in particular, which route should we follow as we approach this watershed in terms of the direction of tax policy for the country in the next decade or two? If I could just have a brief comment from each of you on that overall position.

Dr. HATSOPOULOS. I agree completely with Senator Boren's analogy. Before I attempt to address that, I would like to point out that there is no question that we have to increase national savings,

whether they come from the Government's side or from the private side. I think they can come from both.

It is an accepted view, as Dr. Auerbach explained, that there is nothing much you can do on the private side. I disagree with that. Until recently you could claim that the thing was static, and the savings rate did not move. In recent years, however, we have seen private savings rates go down; so something must have happened to make them go down. If we found what happened that made them go down, we certainly could find what can make them go up.

I agree with Dr. Auerbach that reducing the budget deficit is probably the most obvious way of improving savings, provided it doesn't come from gimmicks like selling assets which does nothing to the national savings rate basically.

I think that another reason why we should focus on the national savings rate, rather than just the budget deficit, is because you lose sight of the goal sometimes. For example, you feel that you have done something by selling assets, when in reality you haven't touched the national savings which is the important parameter.

Senator Boren and I have discussed this issue. Let us assume that we can get the national savings up. We may have to do this, by the way, because foreign investors may soon be unwilling to keep lending us money. We have already seen that as the dollar fell.

There is a concern whether an increase in national savings could depress the economy because we are always talking about increasing national savings, and that means reducing consumption.

The reduction of consumption may depress the economy and I think that is a real worry. It is something we have to do and we have to take the chance, but let's see how we can do it without causing any problem. We want the economy to grow very fast because that would make it easier for us to curtail consumption as a share of national output.

I think the way to do it, the only way to do is through increased net exports and an increased rate of investment. Both of these could be substituted, and they are complementary. An increase of net exports, whether from increased exports or decreased imports, would necessitate an expansion of our industrial productive base.

You may not see it overall in capacity utilization, but I know that many industries already have limited capacity, and these industries are not investing to provide the necessary increases.

So the question of providing the proper environment for investment is even imperative from the standpoint of maintaining economic growth at a time when we have a falling dollar. Capital inflows from abroad are falling, and national savings are bound to increase to keep things balanced.

So I think it is a very appropriate time. I agree with Alan Auerbach that to keep changing the Tax Code confuses business, but the thing is so bad right now that I don't think that we can wait.

I am sorry to take so long, but I would like to answer Senator Boren's question. There is no question in my mind that the next tax increases have to come from some kind of consumption tax because what we are trying to do is to curtail consumption and increase investment.

Now, whether they come with excise taxes; or in some broader-based consumption tax, or some modification of the income tax that allows more productive investment, this is going to have to be debated. I don't think that any of us have an answer to that, but at least it should be debated and it is not being debated right now and this is very unfortunate.

Dr. AUERBACH. If I could add briefly. My reaction is that it is true that the income tax, consumption-type taxes or excise-type taxes are the three sources where the revenue could come from.

My sense is that within the income tax are really two ways: One through a rate increase and the other through a base increase. It would be very unwise to have institutionalized the rates of the 1986 act and now to change them.

There are a number of additional ways of broadening the income tax base that were discussed at some point during the tax reform process that never came in, some things having to do, for example, with employee fringe benefit, taxation of Social Security benefits and a number of other very unpopular measures which, nonetheless, would raise revenue.

In terms of consumption-type taxes, I would prefer the excise tax route or selective tax route to the value-added tax, primarily on the ground that when we talk about a value-added tax we are talking about a new tax that we don't currently have.

The European experience has not been as glowing as we would expect from just thinking about it in theory. There are a lot of things that happen when you try to introduce the value-added tax that make it considerably more complicated than the hypothetical value added tax that people talk about, once you talk about exempt commodities, exempt taxpayers, and so forth.

When one looks at excise taxes, on the other hand, the number of different excise taxes that have been allowed to fall in real terms over the years all add up.

You might be able to raise $15 billion a year from a range of such taxes which, combined with certain base broadening the income tax, would give you some revenue. In addition, you might consider energy taxes.

The only fear I have about energy taxes is that unlike, for example, taxes on tobacco or alcohol, these taxes not only hit households but hit industry. Some allowance ought to be made for that so you don't defeat the objective that you are trying to achieve.

Mr. NORRIS. There is an energy crisis down the road and it will be awful, much worse than the last one. That is where I would place the priority and there are lots of options that have been mentioned in connection with the other areas.

Senator BOREN. Would income tax be your last choice, one to 3 years?

Mr. NORRIS. Basically, but still some increase in income taxes.

Senator BOREN. Thank you very much. I hope we can have this kind of debate. As Senator Levin mentioned, I serve on the Finance Committee also.

One of my frustrations in the 10 years I have been on that Committee is that generally we do not debate tax policy. We are confronted with the need to raise X amount of dollars. However, we are confronted with the decision that we will lower rates this much

and, therefore, we will come up with this much to offset the rate reduction.

In other words, we are given mathematical formulas and we sit down and try to come up with the least terrible alternatives available to us and the least politically painful alternatives to utilize to come up with a certain amount of mathematical figures, and this is not the kind of tax policy debate, it seems to me, that the country needs to be having.

So I appreciate what I have heard here this morning and I do think it is important we not only try to get the savings rate up but that we have to put a correlation with the investment rate because, as Dr. Hatsopoulos has said we have worked ourselves into such a hole that we now have to have a coordinated way of getting out, and if we were to dampen our own consumption through very rapid deficit reduction, budget definite reductions, without having an outlet to keep people working, well, either a large increase in exports or a large increase in the purchase of capital goods and other things that come with basic increases in investment, we could push ourselves into a recession or worse inadvertently.

So it is going to have to take the right kind of coordinated policy that moves in all of the right directions at once and it means it is a much more difficult policy to contrive than it would be if we had not gotten ourselves in these terrible holes with both the trade deficit and budget deficit.

I apologize, Mr. Chairman, that I have to go on to another meeting and I apologize especially for Mr. Norris, but I will read that testimony with interest and I appreciate it.

Senator LEVIN. Thank you, Senator Boren, so much for being able to get here.

Mr. Norris, we turn to you.

STATEMENT OF WILLIAM C. NORRIS, CHAIRMAN EMERITUS, CONTROL DATA CORP., MINNEAPOLIS, MN

Mr. NORRIS. Thank you, Mr. Chairman. I appreciate the opportunity to be present at this hearing to focus on Federal programs and policies that affect the adoption of the advanced manufacturing technology by small- and medium-sized companies.

Senator LEVIN. Would you put your mike a bit closer?

Mr. NORRIS. Is this better?

Senator LEVIN. A little closer, if you would.

Mr. NORRIS. Having been in charge of two small businesses for a period of time, one of which was Control Data, until it grew larger, I have a deep appreciation of the tough problems facing small business today.

One of the most serious is manufacturing. Simply stated, small companies are caught up in the slow rate of adoption of advanced manufacturing technology by industry in our country.

Ironically, and this point has come up several times this morning, the United States possesses much of the advanced manufacturing technology in the world. However, largely it remains in laboratories while our foreign competitors, especially Japanese companies, are capitalizing on it to improve their competitive position in the world markets.

There are many reasons why we are too slow in utilizing advanced manufacturing: The low level of technical capabilities in most manufacturing companies, the dearth of engineers that are knowledgeable in advanced manufacturing, the substantial cost of equipment, the computer software particularly, the high cost of training, the high risk and low rate of return on capital that is well below what is traditionally acceptable.

Of course, aside from the risk and low return considerations, most medium-sized and small companies simply don't have the money. Another factor is the lack of nearly enough cooperation among Government, universities and industry in developing and utilizing manufacturing technology. Not only is technological innovation lagging, there is a deficiency of information available on research and development programs being carried on in a large number of States.

As a result, the wheel is being reinvented in many cases and, worse, the nation is denied the gain of efficiency resulting from cooperation and such losses can be ill-afforded considering the already ferocious foreign competition which will relentlessly increase in intensity during the years ahead.

So the question is how can the United States overcome this formidable array of impediments to getting advanced manufacturing technology in widespread use the soonest? A powerful response is the Advanced Integrated Manufacturing Services Center, which I will abbreviate as AIMS, A-I-M-S. It is a private/public, cooperative initiative being advanced by the Midwest Technology Development Institute.

This organization was formed in 1985 by a consortium of Midwest States to foster large-scale public and private technological cooperation, and one of the fields selected for a cooperative initiative is advanced manufacturing.

The plans are being prepared for a nationwide program for accelerating the widespread utilization of computer-aided design, computer-integrated flexible manufacturing systems, and primary emphasis is placed on the utilization of existing technology as opposed to research and development to create new technology.

The centerpiece of the AIMS Program is a nationwide network of regional and local computer-aided design and computer-aided manufacturing centers. Regional centers will be interconnected and conform to a common set of standards for computer software, data bases and communication protocol.

Each regional center will have access to the computer data bases of other centers. Further, regional centers are connected with and serve local centers providing them access to computer data bases containing information for the automatic manufacture of a wide range of components, subassemblies, and equipments.

Local centers perform manufacturing on a service basis, where companies pay for the service as it is used with no investment required in the regional or local centers. Each company utilizes these facilities through a workstation on its own premises; in other words, a computer terminal connected by a telephone channel.

Initially three types of local centers are planned: Materials forming, electronic circuit card assembly, and then electromechanical assembly. Performance goals for each type of center includes high

quality, low cost, small quantity and a wide range of products and shortest throughput time.

Local centers fabricating parts will be placed in operation first because the required technology is generally available today, whereas, the computer software that is most suitable for computer-integrated manufacturing required by the other two types is still under development.

Now, once regional and local centers are in operation, a product development engineer in a small company in Wisconsin, for example, could design an electronic circuit that could be manufactured in a local AIMS center in northern Minnesota.

Similarly, a product development engineer located in Iowa and Nebraska could have castings made in a local AIMS center in Kansas. Extensive hands-on education will be offered by the centers, also an ability to replicate under a license all or part of the total system. For example, a small company may use a local center to manufacture a new part for a time, and may later on decide that it would be advantageous to install the required automated equipment in its own plant to make it.

An optimum initial number of regional centers is considered to be 10, with 5 to 6 years required to get them in operation.

Most regional centers would serve local centers in a number of States, so that we are talking about a nationwide system. The number and types of local centers to be installed will have to be determined by each state taking into account, of course, the needs to be served. The initial cost of a regional center, including six local centers, is estimated to be $80 million.

Considering the benefits to both the public and private sectors, it is appropriate that the cost be shared by the Federal Government, state and local government and companies.

I am unaware of a precedent for determining the most appropriate division of cost. A number of factors must be taken into account, including the reality that most small companies have very little capital to invest in longer-term projects and the funding capabilities of States vary widely.

In addition, states are not prone to cooperate because the great benefits from such efforts are not widely understood.

Thus, a major part of the initial funding should be provided by the Federal Government. An additional compelling reason supporting this conclusion are the obvious benefits to be derived by our Armed Forces from a nationwide network of AIMS centers in maintaining a military preparedness.

Consequently, it is proposed that the Federal Government underwrite 75 percent of the cost with the balance assumed by State and local governments and companies.

Legislation should also provide that once the centers have achieved reliable operation, that they be purchased by private companies and operated as for-profit businesses. At that point, it is expected that many more centers, all privately financed, would be established.

Now, the benefits spread to both large and small companies. For large companies being able to replicate the entire advanced integrated manufacturing system under a license agreement of course can be very beneficial. There is minimum risk because the cost and

the time for installation are known and, most important, reliable operation of the system has been established.

Large companies can also benefit greatly if their suppliers, many of whom, of course, are small companies, have access to an AIMS center. They will be able to furnish high quality, lower cost parts, subassemblies and products on a timely basis.

These centers are even more significant to cash-strapped medium-sized and small companies because most of them are handicapped by lack of access to advanced manufacturing technology and have no alternative but to wait until turnkey computer-integrated manufacturing systems are available at an affordable cost. That day is likely to be at least 10 years away and probably longer for most.

Yet waiting is not an acceptable alternative to the Nation because more than 60 percent of our manufactured goods come from the small business sector as well as many of our technical advances.

For example, IBM didn't pioneer the electronic computer. This was done by two small companies, Eckert-Mauchley and Engineering Research Associates. Instant photography was invented by a small startup company called Polaroid, not Eastman Kodak, and the list goes on.

However, small businesses will not be able to innovate so successfully in the future if they do not have access to advanced design and manufacturing technology whereby plans for the manufacturing process are drawn at the same time the product is designed.

In other words, the AIMS Program will offer small business an opportunity to introduce new products early in the marketplace at competitive prices with high quality.

I should also note in closing that the AIMS Program is in consonance with the Hollings Centers, authorized in S. 907 of the Technology Competitiveness Act. The objectives of the Hollings Centers are to establish experimental automated manufacturing systems primarily for transfer of the National Bureau of Standards advanced manufacturing technology. This is accomplished by demonstration, education and training, and loan of equipment.

The AIMS Program includes these offerings but in addition and very, very important, provides manufacturing services. So the program as outlined here is a giant step that is needed to get utilization of advanced manufacturing technology on a fast track to improve United States competitiveness at the earliest date.

Thank you.

[The prepared statement of Mr. Norris follows:]

WILLIAM C. NORRIS
CHAIRMAN EMERITUS
CONTROL DATA CORPORATION

STATEMENT BEFORE THE SENATE
INNOVATION, TECHNOLOGY AND PRODUCTIVITY
SUCOMMITTEE OF THE SENATE SMALL BUSINESS COMMITTEE

WASHINGTON, D.C.
MARCH 1, 1988

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:
MY NAME IS WILLIAM C. NORRIS, I AM CHAIRMAN EMERITUS OF CONTROL DATA CORPORATION AND CHAIRMAN OF THE BOARD OF THE MIDWEST TECHNOLOGY DEVELOPMENT INSTITUTE (MTDI).

I WISH TO THANK YOU, MR. CHAIRMAN, FOR THE OPPORTUNITY TO BE PRESENT AT THIS HEARING TO FOCUS ON FEDERAL PROGRAMS AND POLICIES THAT AFFECT THE ADOPTION OF THE ADVANCED MANUFACTURING TECHNOLOGIES BY SMALL AND MEDIUM-SIZED BUSINESSES. HAVING BEEN IN CHARGE OF TWO SMALL BUSINESSES FOR A PERIOD OF TIME, ONE OF WHICH WAS CONTROL DATA, AND HAVING HELPED START MANY MORE SMALL COMPANIES, I HAVE A DEEP APPRECIATION OF THE SERIOUS PROBLEMS FACING SMALL BUSINESS TODAY. ONE OF THE MOST SERIOUS IS MANUFACTURING.

SMALL COMPANIES ARE CAUGHT UP IN THE SLOW RATE OF ADOPTION OF ADVANCED MANUFACTURING TECHNOLOGY BY INDUSTRY IN OUR COUNTRY. BECAUSE OF SUBSTANTIAL RESEARCH AND DEVELOPMENT, WHICH HAS BEEN UNDERWAY FOR MANY YEARS IN OUR UNIVERSITIES AND GOVERNMENT LABORATORIES, THE UNITED STATES POSSESSES MUCH OF THE ADVANCED MANUFACTURING TECHNOLOGY IN THE WORLD. HOWEVER, EXCEPT FOR A HANDFUL OF LARGER COMPANIES, THIS ADVANCED TECHNOLOGY IS NOT BEING WIDELY USED IN MANUFACTURING. IRONICALLY, OUR ADVANCED TECHNOLOGY LARGELY REMAINS IN LABORATORIES, WHILE OUR FOREIGN COMPETITORS -- ESPECIALLY JAPANESE COMPANIES, ARE CAPITALIZING ON IT TO IMPROVE THEIR COMPETITIVE POSITION IN WORLD MARKETS.

YET, MYRIAD ARTICLES AND BOOKS HAVE BEEN PUBLISHED IN RECENT YEARS WARNING THAT MOST AMERICAN COMPANIES ARE MOVING TOO SLOWLY IN THE IMPLEMENTATION OF COMPUTER-INTEGRATED MANUFACTURING. THIS CONCLUSION IS CONFIRMED BY U.S. DEPARTMENT OF DEFENSE STUDIES INDICATING A BROAD CONSENSUS THAT THE UNITED STATES IS, IN FACT, NOT IMPLEMENTING ADVANCED MANUFACTURING TECHNOLOGY FAST ENOUGH. FURTHER, THE STUDIES INDICATE THAT THE COMPETITIVE DECLINE OF A NUMBER OF INDUSTRIES IS UNDERMINING AMERICA'S SECURITY AND ERODING ITS FUTURE STANDARD OF LIVING.

THERE ARE MANY REASONS WHY WE ARE TOO SLOW IN UTILIZING ADVANCED MANUFACTURING SYSTEMS. THEY INCLUDE THE LOW LEVEL OF TECHNICAL CAPABILITIES IN MOST MANUFACTURING COMPANIES; A DEARTH OF ENGINEERS KNOWLEDGEABLE IN ADVANCED

MANUFACTURING; THE SUBSTANTIAL COST OF EQUIPMENT, COMPUTER SOFTWARE AND TRAINING, AND HIGH RISK AND LOW RATE OF RETURN ON CAPITAL THAT IS WELL BELOW WHAT IS TRADITIONALLY ACCEPTABLE. ASIDE FROM THE RISK AND LOW RETURN CONSIDERATIONS, MOST MEDIUM-SIZED AND SMALL COMPANIES SIMPLY DON'T HAVE THE MONEY.

ANOTHER FACTOR IS THE LACK OF NEARLY ENOUGH COOPERATION AMONG GOVERNMENT, UNIVERSITIES AND INDUSTRY IN DEVELOPING AND UTILIZING ADVANCED MANUFACTURING TECHNOLOGY. NOT ONLY IS TECHNOLOGICAL COOPERATION LAGGING, THERE IS A DEFICIENCY OF INFORMATION AVAILABLE ON RESEARCH AND DEVELOPMENT PROGRAMS BEING CARRIED ON IN A LARGE NUMBER OF STATES. AS A RESULT, THE WHEEL IS BEING REINVENTED IN MANY PLACES. WORSE, THE NATION IS DENIED THE GAIN IN EFFICIENCY RESULTING FROM COOPERATION -- SUCH LOSSES CAN BE ILL AFFORDED, CONSIDERING THE ALREADY FEROCIOUS FOREIGN COMPETITION, WHICH WILL RELENTLESSLY INCREASE IN INTENSITY DURING THE YEARS AHEAD.

ADVANCED MANUFACTURING SERVICE CENTER (AIMSC) PROGRAM

HOW CAN THE UNITED STATES OVERCOME THIS FORMIDABLE ARRAY OF IMPEDIMENTS TO GETTING ADVANCED MANUFACTURING TECHNOLOGY IN WIDESPREAD USE THE SOONEST? A POWERFUL RESPONSE IS THE ADVANCED INTEGRATED MANUFACTURING SERVICE CENTER (AIMSC) PARTNERSHIP. IT IS A PUBLIC/PRIVATE COOPERATIVE INITIATIVE BEING ADVANCED BY THE MIDWEST TECHNOLOGY DEVELOPMENT INSTITUTE (MTDI). THIS ORGANIZATION, FORMED IN EARLY 1985

BY A CONSORTIUM OF MIDWEST STATES, FOSTERS LARGE SCALE PUBLIC/PRIVATE TECHNOLOGICAL COOPERATION. ONE OF THE FIELDS SELECTED FOR A COOPERATIVE INITIATIVE IS ADVANCED MANUFACTURING.

PLANS ARE BEING PREPARED FOR A NATIONWIDE PROGRAM FOR ACCELERATING THE WIDESPREAD UTILIZATION OF COMPUTER-AIDED DESIGN AND COMPUTER-INTEGRATED FLEXIBLE MANUFACTURING SYSTEMS. PRIMARY EMPHASIS IS ON THE UTILIZATION OF EXISTING TECHNOLOGY, AS OPPOSED TO RESEARCH AND DEVELOPMENT TO CREATE NEW TECHNOLOGY. HOWEVER, THE AIMSC PARTNERSHIP WILL ENCOURAGE COOPERATION, ESPECIALLY AMONG UNIVERSITIES AND GOVERNMENT LABORATORIES, IN ONGOING RESEARCH AND DEVELOPMENT. IN ADDITION, CLOSE WORKING RELATIONSHIPS WILL BE MAINTAINED TO HELP ELIMINATE DUPLICATION OF EFFORT AND TO ASSURE THAT THE TECHNICAL EFFORT IS MOST RESPONSIVE TO THE NEED.

THE CENTERPIECE OF THE AIMSC PROGRAM IS A NATIONWIDE NETWORK OF REGIONAL AND LOCAL COMPUTER-AIDED DESIGN AND COMPUTER-AIDED MANUFACTURING CENTERS. REGIONAL CENTERS WILL BE INTERCONNECTED AND CONFORM TO A COMMON SET OF STANDARDS FOR COMPUTER SOFTWARE, DATA BASES AND COMMUNICATION PROTOCOLS. EACH REGIONAL CENTER WILL HAVE ACCESS TO THE COMPUTER DATA BASES OF OTHER CENTERS. FURTHER, REGIONAL CENTERS ARE CONNECTED WITH AND SERVE LOCAL CENTERS PROVIDING THEM ACCESS TO COMPUTER DATA BASES CONTAINING INFORMATION FOR THE AUTOMATIC MANUFACTURE OF A

WIDE RANGE OF COMPONENTS, SUBASSEMBLIES AND EQUIPMENTS. LOCAL CENTERS PEFORM MANUFACTURING ON A SERVICE BASIS, WHERE COMPANIES PAY FOR THE SERVICE AS IT IS USED WITH NO INVESTMENT REQUIRED IN THE REGIONAL OR LOCAL CENTERS. EACH COMPANY UTILIZES THESE FACILITIES THROUGH A WORK STATION ON ITS OWN PREMISES, CONNECTED BY A TELEPHONE CHANNEL.

INITIALLY, THREE TYPES OF LOCAL CENTERS ARE PLANNED: MATERIALS FORMING, ELECTRONIC CIRCUIT CARD ASSEMBLY AND ELECTRO-MECHANICAL ASSEMBLY. PERFORMANCE GOALS FOR EACH TYPE OF CENTER INCLUDES HIGH QUALITY, LOW COST, SMALL QUANTITY AND WIDE RANGE OF PRODUCTS AND SHORTEST THROUGHPUT TIME.

LOCAL CENTERS FABRICATING PARTS WILL BE PLACED IN OPERATION FIRST, BECAUSE THE REQUIRED TECHNOLOGY IS GENERALLY AVAILABLE; WHEREAS, COMPUTER SOFTWARE MOST SUITABLE FOR COMPUTER-INTEGRATED MANUFACTURING REQUIRED BY THE OTHER TWO TYPES IS STILL UNDER DEVELOPMENT.

ONCE REGIONAL AND LOCAL CENTERS ARE IN OPERATION, A PRODUCT DEVELOPMENT ENGINEER IN A SMALL COMPANY IN WISCONSIN, FOR EXAMPLE, COULD DESIGN AN ELECTRONIC CIRCUIT THAT WOULD BE MANUFACTURED IN A LOCAL AIMS CENTER IN NORTHERN MINNESOTA. SIMILARLY, PRODUCT DEVELOPMENT ENGINEERS, LOCATED IN IOWA AND NEBRASKA, COULD HAVE CASTINGS MADE IN A LOCAL AIMS CENTER IN KANSAS.

ADDITIONAL UTILIZATION OPTIONS AVAILABLE FOR MANUFACTURING COMPANIES USING THE LOCAL CENTERS INCLUDE THE RIGHT TO REPLICATE, UNDER A LICENSE, ALL OR PART OF THE AIMSC SYSTEM. FOR EXAMPLE, A SMALL COMPANY MAY USE A LOCAL AIMS CENTER TO MANUFACTURE A NEW PART FOR A TIME AND LATER ON DECIDE THAT IT WOULD BE ADVANTAGEOUS TO INSTALL THE REQUIRED AUTOMATIC EQUIPMENT IN ITS OWN PLANT TO MAKE IT.

EXTENSIVE EDUCATION AND TRAINING WILL BE OFFERED BY THE CENTERS, WITH COMPUTER-BASED EDUCATION AS THE PRIMARY METHOD OF DELIVERY. THIS METHOD WILL ASSURE THE MOST ACCESSIBLE, UNIFORMLY HIGH QUALITY AND LEAST COSTLY EDUCATION AND TRAINING IN THE UTILIZATION OF COMPUTER-AIDED DESIGN AND COMPUTER-INTEGRATED MANUFACTURING TECHNIQUES.

A FACTOR CRITICAL TO THE SUCCESS OF TRAINING LIES IN THE PRACTICAL, HANDS-ON SKILLS WHICH MUST BE ACQUIRED. IN THE AIMS CENTERS, THIS WILL BE ACCOMPLISHED THROUGH ACTUAL OPERATION OF THE FACILITY BY PERSONNEL FROM USER FIRMS. TO FACILITATE THIS, THE AIMS CENTERS WILL OFFER INTERNSHIPS TO INDUSTRY AND ACADEMIA. UNIVERSITIES INVOLVED WILL SPONSOR GRADUATE STUDENTS TO FILL THEIR INTERNSHIP POSITIONS, THUS OPENING AN ADDITIONAL TRAINING CHANNEL, BOTH FOR LEARNING ABOUT INDUSTRY NEEDS AND FOR TRANSFERRING THE RESULTS OF MANUFACTURING RESEARCH CARRIED OUT BY THE UNIVERSITIES.

AN OPTIMUM INITIAL NUMBER OF REGIONAL CENTERS IS CONSIDERED TO BE TEN, WITH FIVE TO SIX YEARS REQUIRED TO GET THEM IN

OPERATION. MOST REGIONAL CENTERS WOULD SERVE LOCAL CENTERS IN A NUMBER OF STATES.

THE NUMBER AND TYPES OF LOCAL CENTERS TO BE INSTALLED WILL HAVE TO BE DETERMINED BY EACH STATE BY TAKING INTO ACCOUNT THE NEEDS TO BE SERVED IN THE MANUFACTURING SECTOR AND THE TRAVEL DISTANCES FOR MANUFACTURING COMPANY EMPLOYEES TO WITNESS DEMONSTRATIONS AND GET HANDS-ON TRAINING IN A FACTORY SETTING.

THE INITIAL COST OF A REGIONAL CENTER, INCLUDING SIX LOCAL CENTERS, IS ESTIMATED TO BE $80 MILLION.

CONSIDERING THE BENEFITS TO BOTH THE PUBLIC AND PRIVATE SECTORS, IT IS APPROPRIATE THAT THE COST BE SHARED BY THE FEDERAL GOVERNMENT, STATE AND LOCAL GOVERNMENTS AND COMPANIES. I AM UNAWARE OF A PRECEDENT FOR DETERMINING THE MOST APPROPRIATE DIVISION OF COST. CERTAINLY, IT MUST BE TAKEN INTO ACCOUNT THAT LESS POPULOUS STATES AND MEDIUM-SIZED AND SMALL COMPANIES NEED THE ADVANCED MANUFACTURING SERVICE EVEN MORE THAN MORE POPULOUS STATES AND LARGE COMPANIES, BECAUSE THEIR ALTERNATIVES ARE MORE LIMITED. MOST SMALL AND MEDIUM-SIZED COMPANIES HAVE VERY LITTLE CAPITAL TO INVEST IN LONGER TERM PROJECTS.

DURING AN ERA OF TIGHT BUDGETS, GETTING AN APPROPRIATION APPROVED BY A STATE LEGISLATURE TO FUND A NEW ACTIVITY, WHICH REQUIRES A REALLOCATION OF FUNDS OR AN INCREASE IN

THE OVERALL BUDGET, CALLS FOR POLITICAL LEADERSHIP OF THE HIGHEST ORDER.

COMPOUNDING THE FUNDING IMPEDIMENT IN STATE LEGISLATURES IS THE PREVAILING LACK OF INTEREST THAT MANY STATE GOVERNMENTS HAVE IN COOPERATING WITH OTHER STATES. UNFORTUNATELY, COMPETITION AND NOT COOPERATION CHARACTERIZES THE RELATIONSHIPS AMONG STATES. A TYPICAL INITIAL REACTION TO A PROPOSED COOPERATIVE PROGRAM BY A GOVERNOR IS, "HOW CAN I JUSTIFY USING TAXPAYERS' MONEY IN MY STATE TO FUND AN ORGANIZATION HEADQUARTERED IN ANOTHER STATES?" OF COURSE, THIS REACTION IS A DERIVATIVE OF THE LACK OF UNDERSTANDING OF THE GREAT BENEFITS OF LARGE SCALE TECHNOLOGICAL COOPERATION AND OF HOW TO EQUITABLY DISTRIBUTE BENEFITS AMONG PARTICIPANTS.

THE INTERRELATED IMPEDIMENTS OF AVAILABILITY OF FUNDS AND THE LACK OF PERCEPTION BY STATE GOVERNMENTS OF THE BENEFITS FROM LARGE SCALE TECHNOLOGICAL COOPERATION INDICATES THAT INITIALLY, A MAJOR PART OF THE FUNDING SHOULD BE PROVIDED BY THE FEDERAL GOVERNMENT. AN ADDITIONAL COMPELLING REASON, SUPPORTING THIS CONCLUSION, ARE THE OBVIOUS BENEFITS TO BE DERIVED BY OUR ARMED FORCES FROM A NATIONWIDE NETWORK OF AIMS CENTERS IN MAINTAINING MILITARY PREPAREDNESS.

CONSEQUENTLY, IT IS PROPOSED THAT THE FEDERAL GOVERNMENT UNDERWRITE 75% OF THE COST WITH THE BALANCE ASSUMED BY STATE AND LOCAL GOVERNMENTS AND COMPANIES.

LEGISLATION SHOULD ALSO PROVIDE THAT ONCE THE CENTERS HAVE ACHIEVED RELIABLE OPERATION, THEY WOULD BE PURCHASED BY PRIVATE COMPANIES AND OPERATED AS FOR-PROFIT BUSINESSES. AT THAT POINT, IT IS EXPECTED THAT MANY MORE CENTERS, ALL PRIVATELY FINANCED, WOULD BE ESTABLISHED. THE PROCEEDS FROM THE SALE WOULD BE USED TO FUND FURTHER RESEARCH AND DEVELOPMENT OF ADVANCED MANUFACTURING TECHNOLOGY.

BENEFITS

BOTH LARGE AND SMALL COMPANIES WILL BENEFIT. FOR LARGE COMPANIES, BEING ABLE TO REPLICATE THE ENTIRE ADVANCED INTEGRATED MANUFACTURING SYSTEM UNDER A LICENSE AGREEMENT CAN BY VERY BENEFICIAL. THERE IS MINIMUM RISK BECAUSE THE COST AND THE TIME FOR INSTALLATION ARE KNOWN, AND MOST IMPORTANT, RELIABLE OPERATION OF THE SYSTEM HAS BEEN ESTABLISHED. THUS, PLANNED PERFORMANCE AGAINST BUDGET CAN, WITH CONFIDENCE, BE EXPECTED.

LARGE COMPANIES CAN ALSO BENEFIT GREATLY IF THEIR SUPPIERS, MANY OF WHOM ARE SMALL COMPANIES, HAVE ACCESS TO AN AIMS CENTER. THEY WILL BE ABLE TO FURNISH HIGH QUALITY, LOWER COST PARTS, SUBASSEMBLIES AND PRODUCTS ON A TIMELY BASIS.

AIMS CENTERS ARE EVEN MORE SIGNIFICANT TO CASH-STRAPPED MEDIUM-SIZED AND SMALL COMPANIES BECAUSE MOST OF THEM ARE HANDICAPPED BY LACK OF ACCESS TO ADVANCED MANUFACTURING TECHNOLOGY AND HAVE NO ALTERNATIVE BUT TO WAIT UNTIL TURNKEY COMPUTER-INTEGRATED MANUFACTURING SYSTEMS ARE AVAILABLE AT AN AFFORDABLE COST. THAT DAY IS LIKELY TO BE AT LEAST TEN YEARS AWAY AND PROBABLY LONGER FOR MOST.

YET, WAITING IS NOT AN ACCEPTABLE ALTERNATIVE TO THE NATION, BECAUSE MORE THAN 60% OF OUR MANUFACTURED GOODS COME FORM THE SMALL BUSINESS SECTOR, AS WELL AS MANY OF OUR TECHNICAL ADVANCES.

IBM DIDN'T PIONEER THE ELECTRONIC COMPUTER. THIS WAS DONE BY TWO SMALL COMPANIES, ECKERT-MAUCHLEY AND ENGINEERING RESEARCH ASSOCIATES. INSTANT PHOTOGRAPHY WAS INVENTED BY A SMALL STARTUP COMPANY, POLAROID, NOT EASTMAN KODAK. AND THE LIST GOES ON.

HOWEVER, SMALL BUSINESSES WILL NOT BE ABLE TO INNOVATE SO SUCCESSFULLY IN THE FUTURE IF THEY DO NOT HAVE ACCESS TO ADVANCED DESIGN AND MANUFACTURING TECHNOLOGY WHEREBY PLANS FOR THE MANUFACTURING PROCESS ARE DRAWN AT THE SAME TIME THE PRODUCT IS DESIGNED. IN OTHER WORDS, THE AIMSC PROGRAM WILL OFFER SMALL BUSINESS AN OPPORTUNITY TO INTRODUCE NEW PRODUCTS EARLY IN THE MARKETPLACE AT COMPETITIVE PRICES WITH HIGH QUALITY.

ANOTHER INTERRELATED BENEFIT FROM THE AIMSC PROGRAM IS THAT OF ACCELERATING THE PROCESS OF GETTING TECHNOLOGY FROM THE LABORATORY INTO THE MARKETPLACE BY BOTH LARGE AND SMALL COMPANIES. AS WE KNOW ALL TOO WELL, A NUMBER OF COUNTRIES, ESPECIALLY JAPAN AND WEST GERMANY, ARE DOING MUCH BETTER IN

THIS RESPECT THAN THE U.S. THUS, THE AVAILABILITY OF A COMPUTER-AIDED DESIGN, COMPUTER-INTEGRATED MANUFACTURING FACILITY TO SPEED UP THE COMMERCIALIZATION OF TECHNOLOGY IS CRITICALLY IMPORTANT TO OUR NATIONAL ECONOMY.

FINALLY, AND MOST IMPORTANT, THE MAJOR THRUST OF AIMS CENTERS IS NOT DEVELOPING TECHNOLOGY BUT GETTING EXISTING ADVANCED MANUFACTURING TECHNOLOGY IN USE THE SOONEST. TECHNOLOGY WILL BE DRAWN FROM MANY SOURCES, INCLUDING THE NATIONAL BUREAU OF STANDARDS, DEPARTMENT OF DEFENSE, STATE AND PRIVATE SECTOR PROGRAMS.

I SHOULD ALSO NOTE THAT THE AIMSC PROGRAM IS IN CONSONANCE WITH THE HOLLINGS CENTERS, AUTHORIZED IN S.907 TECHNOLOGY COMPETITIVENESS ACT. THE OBJECTIVES OF THE HOLLINGS CENTERS ARE TO ESTABLISH EXPERIMENTAL AUTOMATED MANUFACTURING SYSTEMS PRIMARILY FOR TRANSFER OF NBS ADVANCED MANUFACTURING TECHNOLOGY. THIS IS ACCOMPLISHED BY DEMONSTRATION, EDUCATION AND TRAINING AND LOAN OF EQUIPMENT. THE AIMSC PROGRAM INCLUDES THESE ACTIONS BUT IN ADDITION, AND VERY IMPORTANT, PROVIDES MANUFACTURING SERVICES.

THE AIMSC PROGRAM IS THE GIANT STEP THAT IS NEEDED TO GET UTILIZATION OF ADVANCED MANUFACTURING TECHNOLOGY ON A FAST TRACK TO IMPROVE THE COMPETITIVENESS OF U.S. INDUSTRY AT THE EARLIEST DATE.

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Senator LEVIN. Thank you very much, Mr. Norris. Were you here when Mr. Corner testified earlier today?

Mr. NORRIS. Yes.

Senator LEVIN. I take it that your AIMS approach is very similar to his shared flexible computer-integrated manufacturing facilities?

Mr. NORRIS. That's correct.

Senator LEVIN. What is the status of your proposal?

Mr. NORRIS. We have an appropriation that has been financed primarily by private companies in the State of Minnesota. A design effort has been started and we have been working with a number of other States, South Dakota, North Dakota, Nebraska, to formulate the details.

The State of Minnesota, that is, the Governor, has requested a larger appropriation which the state legislature seems prone to support, and that is the status.

Senator LEVIN. Is there any Federal program which can supply funds for this that you can identify?

Mr. NORRIS. The Hollings bill, if it passes, but that is not a program yet.

Senator LEVIN. You figure it would be about $80 million for each of the 10 regional centers?

Mr. NORRIS. Yes. This correlates fairly well with Mr. Corner's estimate of $50 million. The center he is talking about I believe will not offer as comprehensive a service as one I am talking about, that is, a larger array of equipment. So I think they track pretty well.

Senator LEVIN. Can you tell us what the size of that center would be? Is there any way you could describe for us the size of that center?

Mr. NORRIS. The physical size? 25,000 to 50,000 square feet.

Senator LEVIN. That is the regional center?

Mr. NORRIS. Yes.

Senator LEVIN. How about the local centers?

Mr. NORRIS. The local centers would be roughly the same size. It would depend, of course, on what is being manufactured.

The important point here, and it was mentioned earlier, is the idea of networking, the center being interconnected. It is extremely important to have them interconnected so that you get the versatility that is required.

Each center will specialize to a considerable extent in a certain type of component or subassembly or product, so that a small business can select a center out of a number, and then it could probably find the facility that will best meet its need.

Senator LEVIN. Dr. Hatsopoulos and Dr. Auerbach, let me ask you about the tax bill. I don't want to go and refight that battle, even though the two of us that were here represented probably 10 percent of the Senators that voted against it. So we are not particularly objective on this subject.

You have indicated, at least implied, that there was very little discussion about the impact of that tax bill on savings, on investment, capital formation.

I would like to ask you both why you believe that was true and why there wasn't more opposition to it from that portion of the community which would be negatively impacted either in terms of

capital formation or in terms of the way in which we treat investment?

I was particularly struck by that since it has been kind of a lonely position there for a while. There were only three of us opposed until we ended up I think with 16 or 18 who finally voted against it.

It always struck me there was a negative impact on capital formation and, yet, we had a few groups speaking in opposition, but it just didn't seem to me that the opposition from the perspective that you have discussed ever gelled for that tax reform bill.

If we could find out why that is true without particularly refighting that battle, I think it might be useful in terms of the future, in terms of future tax policy if we can understand why that particular tax reform approach sort of sailed through without a lot of formal opposition.

Dr. HATSOPOULOS. I think that I can answer, sort of from the insider's point of view, and Alan can answer from the outsider's point of view.

It is very clear to me what happened, for I was involved in that conflict. Essentially the Tax Reform Act of 1986 provided an enormous inducement to the business community on several levels.

One such inducement was the provision to relieve the tax burden from all existing capital at the expense of new capital. That means existing stockholders were getting a windfall. It essentially traded investment tax credit for a reduction in the corporate tax rate.

What you do is reduce the taxation on the capital that is in place, because now the returns on that capital pay fewer taxes. You don't worry about the capital that is not in place, so essentially you benefit existing stockholders of established companies. The more established the company, the better the stockholders will gain from the new tax structure. It is a windfall, because I believe that when these people bought equities in IBM, General Motors, and the like, including my own company, they paid with the understanding that the returns would be taxed at a certain level. They went in, fully cognizant of the rate at which those returns would be taxed. All of a sudden you say to them that you are going to reduce the tax rate on their existing capital, so naturally everybody is enthused.

The second level of inducement is at the personal level. Let me tell you that I was trying to point out the defects of the 1986 tax bill. In one particular case my wife said to me. "George, what are you doing here, you want us to pay more taxes?" This bill reduces our taxes a lot, personally. It increases the value of our stock because now the returns on the existing capital are taxed less and personally we gain. I said, "Don't worry about it, no one is going to listen to me so I can act patriotically."

The point is that there were enormous benefits to businesses that had already put their money in. To me that is the major reason why opposition was weak, and it is very clear-cut.

Senator LEVIN. Dr. Auerbach.

Dr. AUERBACH. I guess it is not surprising that as an outsider it is not as clear-cut to me. In fact, I still find it difficult to understand how we could have a very, very major cut in business taxes

and increase in investment incentives in 1981, followed by, under the same administration, a reversal of that in 1986.

So if I don't understand that I am not sure I can explain anything else. I am not so sure that the business community felt that this was a good thing because of the so-called bribes they were receiving because there was also an increase in business taxes.

It is true that certain companies and certain shareholders gain from the act, particularly when you take individual taxes into consideration, but there were certain industries that had very large increases in taxes, too, and they certainly weren't happy about what happened.

Senator LEVIN. They may not have been happy, but we didn't hear from any of them. We didn't hear from any of those businesses.

My question is, I think we will understand this tax system better in terms of the future if we can understand exactly what happened. The proponents of the tax bill were talking about all of those special interests up there, those Gucci shoes out in the hallway. We were going to finally raid in on this tax bill.

Yet, when you came to look at the list of supporters for the tax bill, the list was that long. It had every association in town except about six. Those of us who opposed the tax bill, in part because of the reasons identified here, because of its impact on savings and investment, that being one of the reasons.

When we went looking for support, we could find almost none. It was ironic that this was an attack on the special interest and yet almost every major association in this town either was neutral on it or was for it. There were very few that were opposed to it.

There was perhaps the realtors at the end, perhaps at the end spoke up. I want to be fair. My memory may be way off. There were some capital formation groups; very few that did speak out against it.

I am curious as to how you explain a big increase in taxes on business, a reduction in incentives for savings and investment and capital formation, at least the way we saw it, some of us, and yet the business community for the most part, 90 percent of the business community was solidly behind that tax reform.

If we could understand that, I think we could understand future changes a little better. I interrupted you, Doctor.

Dr. AUERBACH. I am glad you posed the conundrum. I certainly agree with it. My observation while watching the tax reform process is it started out as something revenue neutral on the business side and on the individual side and represented a closing of loopholes and lowering of rates. As it continued, however, another characteristic it took on was a shifting of taxes from individuals to businesses. I took this to be the result of the perceived need to get the population behind the tax bill.

Senator LEVIN. Let me ask one last question of each of you. I believe one of you has answered this question but let me ask it again to all.

What is the single most important doable thing, the most important doable thing that we can do through the Tax Code or otherwise to stimulate savings, capital formation and specifically the use

by small and medium business of advanced technology? The word doable is very important.

We will not restructure the Tax Code for all kinds of reasons we have heard already. We probably can't do anything on that capital gain for risky ventures for the same reason. I would exclude that from the doable category both in terms of changing the rules again but also in terms of perhaps the political factors.

If you think that is doable and want that to be your one doable item, so be it, and make that your answer.

Give us, even if it is a small thing, if it is doable, what is the most important doable thing we can do either in the Tax Code or otherwise?

Mr. Norris has given us a specific proposal. If he puts that in a doable category, that would be his answer perhaps to my question.

Start with you, Dr. Auerbach.

Dr. AUERBACH. It was an easy question until you said the word "doable."

Senator Levin. That's why I repeated it six times.

Dr. AUERBACH. Frankly I think more than any specific tax policy which presumably is going to be a small and targeted thing and not raise or cost much revenue, just a tax increase which is not anti-business in the sense of not raising the cost of capital or the cost of materials would help in the sense of preventing business costs from being as high as they are and making it possible for there to be more investment and more competitive production.

Dr. HATSOPOULOS. I tend to agree with Dr. Auerbach. The word "doable," of course, you raised and I know what you mean by it.

Senator LEVIN. Politically doable.

Dr. HATSOPOULOS. If you were talking about what makes economic sense in the broadest sense of the word——

Senator LEVIN. No.

Dr. HATSOPOULOS. All right.

Senator LEVIN. That's for the classroom.

Dr. HATSOPOULOS. First of all, I am not that knowledgeable on the political front, or which things we can change drastically. Everything might change with a new President, so it is pure speculation.

I think if you exclude all of the things you mentioned, then I agree with Dr. Auerbach, an increase of some kind of consumption tax would make more money available for investment. Furthermore, if we can find a way to slant the benefits toward equities, which I feel is the key to mid-sized and small-growth companies, I think it would be even more effective. However, you do need to have more capital before you can lower the cost of capital.

If I may, Mr. Chairman, add something to your previous question. You said why has there been no support?

In reality, if you consider the assets you as a company have in hand; the moment the investment tax credit is eliminated, these assets are worth 10 percent more because the person that wants to buy them now must pay the full amount. Before the ITC was eliminated he could buy new equipment and get a 10 percent credit. You have increased in one stroke the value of existing assets by somewhere close to 10 percent. That is an enormous increase in value.

And if you look at the stock market's behavior after that change, some of it could be attributed to the elimination of the tax credit.

Senator LEVIN. A very compelling point. Thank you, Doctor.

Mr. Norris, do you want to wind up for us?

Mr. NORRIS. I don't know how to solve the problem we are addressing here today of getting small businesses more competitive with advanced manufacturing technology by tax policy changes simply because there is the absence of capital.

Also, it is a matter of risk. They don't know how to use the equipment even if they had the capital to buy it. So it is mainly a need for priming the pump for small businesses, priming the technological pump. You have to share risk with them. And in return, once they have the knowledge and once they know how to use this equipment, then tax policies could be very important.

Senator LEVIN. Well, we are grateful to all three of you, both for being here, for your illuminating testimony, for your patience in waiting for your panel to be called.

These hearings are extremely helpful to all of us and we will be in touch with a number of you for further help as we go along and we appreciate again your presence here. Thanks so much.

We will stand adjourned.

[Thereupon, at 12:38 p.m., the Subcommittee adjourned subject to the call of the Chair.]

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